SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 25.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 25.

NEW-YORK JUNE 17, 1876.

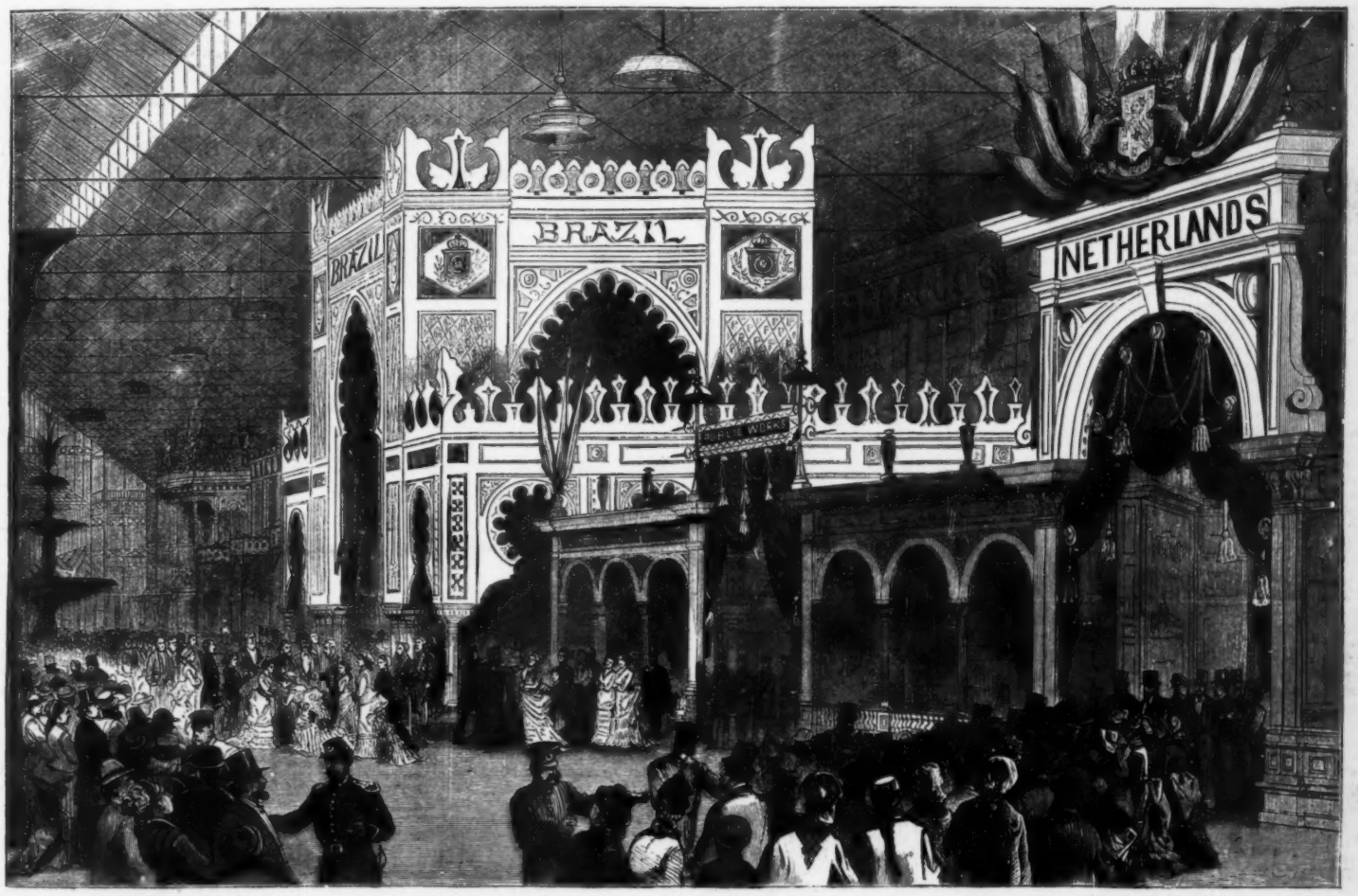
Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

BRAZILIAN EXHIBITS.

THE Brazilians have erected a very conspicuous and elegant structure in the Main Building, as shown in our view from *Frank Leslie's*. The display of Brazilian products at this point and in other departments of the Exhibition is very good, embracing a great variety of objects.

The exhibits of the silk industries of Brazil are quite interesting, especially that by one of the Brazilian Commissioners, Luis de Rezende, the owner of the largest silk raising and manufacturing establishment in the country, and by Morris N. Kohn, who was the Special Commissioner. Mr. Kohn shows the original cocoon "mother" of all the silk family of the Asiatic silkworm in the country. It is curiously stamped with the official seal, showing its authenticity, and dated in 1826. The silk-growing interest of Brazil is here set out in the most attractive form, showing the 100,000 mounted mud berry trees in the plantation of Commissioner Rezende, and giving in all its stages the manufacture of silk, from the laying of the egg to the production of the cloth. The silk is stronger and has more lustre, though it is not so soft as the India thread. But Brazil can raise six crops a year, while China can bring forth only two.

In the Brazilian Government exhibit, machinery used in the War and Navy Bureaus is conspicuous. A machine for coining the Brazilian money is also here. Models of the ships in the Brazilian navy, of marine armaments, of army munitions and *impedimenta*, are also complete in the collection.



THE INTERNATIONAL EXHIBITION OF 1876.—THE BRAZILIAN CANOPY—MAIN BUILDING.

THE INTERNATIONAL EXHIBITION OF 1876.

SWEDISH IRON AND STEEL IN THE MAIN BUILDING.

No. 9.

IN the Swedish section of the Main Exhibition Hall is to be seen one of the finest and most extensive exhibits of steel and iron products ever gotten together; and it is much to be regretted that it was not made in the more appropriate Machinery Hall, where that country has a quite extensive and interesting collection of other matters.

The Sandvik Works show specimens of work made from Bessemer steel in great variety, which extend from a steamship shaft to the finest razor. The articles from this firm are exclusively of the Bessemer metal, the production and manipulation of which material seems to have been made a specialty with them. Among the many articles from their works are the following: A steam-engine, double crank-shaft with one throw slotted out, showing the homogeneity of the metal, which has, for this material, the very considerable weight of three tons; a propeller shaft 27 feet 10 inches long, 9¾ inches in diameter, with flange of 27 inches diameter, and weighing 3½ tons. This shaft is finished through part of its length only, in order to show not only the character of the metal as to freedom from defects where finished, but also the workmanship exhibited in the forging, which latter in all their specimens is most excellent. Another, and perhaps one of the heaviest finished pieces ever made from this metal, is a piston and rod in one piece, belonging to or made for a 15-ton steam-hammer, which is to be in operation at their works. This piece is 13 feet 7½ inches long, with the rod portion 16 inches and the piston 38 inches in diameter. It weighs in its finished state 5 tons, and is without a blemish or flaw that can anywhere be detected by the naked eye. There are locomotive connecting-rods, axles, cranks, cross-heads, and other articles, which, as specimens of the blacksmith's art, are most admirable; then they show locomotive wheel-tires which have been in service, and are removed from their wheels expressly for exhibition, and which are accompanied by authenticated records of the amount of wear they have been subjected to; among these is a tire which, although still in good serviceable condition, has been at work ten and a half years and run nearly 200,000 English miles, and there are others which have had but little less of service.

They also exhibit tires bent and twisted cold into every conceivable distortion, to illustrate the toughness and tenacity of the metal; these characteristics of the Bessemer steel are also curiously shown in a number of pieces of round bars of varying diameter, from 2 to 3½ inches, tied into knots, cold, without rupture or the least disintegration, even upon the surface at the exterior circumferences of the curves.

They show a case of files of extraordinary size, the largest being a square file 4 feet 8½ inches long, about 4 inches through at its largest section, and weighing 109 lbs.

Perhaps the most curious object exhibited by this firm is an ingot of this metal, 30 inches square, and weighing 5½ tons, which has been purposely ruptured to exhibit the texture of the metal before working under the hammer, in contrast with its perfect homogeneity when finished. To one who has never had the privilege of witnessing such operations, the feat of breaking in two an ingot of steel, having a section through of 30 inches each way, with the entire piece less than 4 feet long, would seem a mechanical impossibility; this has not only been done, however, but the fracture is as square across as though cut by some mechanical process, and, but for the peculiar surface characteristics of fracture, it might be supposed to have been severed by the planing machine. The operation was performed by planing a groove on two opposite sides about 2½ inches deep, to determine the line of fracture, and quoining into them with repeated blows upon the quoins from a 15 ton steam hammer. The clear section broken through is about 750 square inches, or over 5 square feet. Several curiosities in the way of long spiral chips or shavings, formed in turning the Bessemer metal, are shown, in which, probably better than in any other way, the extreme toughness of this product is illustrated. One of these shavings, wound upon a reel and in one piece, is 752 feet long, and would measure if straightened out not less than 4100 feet. Another, and probably the longest specimen in existence, is wound upon a tall column, and has the extraordinary length of 1135 feet in its curved state.

Next in extent is the exhibit of the Fagersta Steel Works. They exhibit a large column made up of railroad and other bars, about 30 feet in height, containing bars of not less than 25 feet long, of all sizes and forms. From the top of this to surrounding cases are festooned spiral shavings of Bessemer steel, making an ornamental and effective display. The value of this metal for boiler plates is shown in a specimen of a furnace flue of a steam boiler, which had been permitted to become overheated under steam pressure sufficiently to produce a depression in the crown sheet in four different places where the local overheating took place, to the depth of about 2 inches, without any more serious results; the boiler having been in use thereafter until returned to the Grötеburg Engineering Works, where it was made, for repairs.

This establishment also exhibit a considerable number of crank-axles, crank-pins, cross-heads, connecting-rods, and volute and sheaf springs, with various other articles pertaining to locomotive and other machinery, and all of the most excellent workmanship, both as to forging and finish.

The most interesting and altogether conclusive part of this exhibit, however, are the several large show-cases containing specimens prepared from the ordinary product of the works, which have been finished to uniform sections, and subjected to all the known tests for tensile, transverse, torsional, and compressive strain; the fractured or modified specimens being shown together with tabulated data over the signature of Mr. David Kirkaldy, by means of which the characteristics and value of their products for the resistance to the various stresses inseparable from engineering structures may be ascertained with certainty. This exhibit is very thorough and

comprehensive, and will be of exceeding interest to the engineering world.

A number of other Swedish exhibitors make a splendid collective exhibit, in the shape of seven ornamental columns surmounting a show-counter of semicircular form, with two larger columns erected upon the floor in front of it. These columns, as with those already mentioned, are made up of specimens of bars of all kinds; while the other objects, which could not be so well arranged in that form, are distributed over the counter. The Messrs. Uddeholms, in this collection, make an exhibit similar to the two concerns already mentioned, but on a much smaller scale. Mr. J. O. Sunström shows a large number of specimens of Swedish iron in great variety of form, together with the ores from which they are obtained. Mr. C. T. Hermanson exhibits some fine specimens of that indispensable material in the Bessemer process, spiegeleisen; together with blast furnace products, and a very curious counterfeit of the rein-deer, made up of various kinds of nails.

The Ramnäs Iron Works present a very interesting and instructive exhibit of chilled conical shot, and railroad wheels and frogs. The solid shot have been split through the centre longitudinally in the most perfect manner by drilling and quoining, and the wheels and other objects fractured to show the texture of the material, as well as the depth to which the chilling has been carried. In the case of the shot, the latter effect has been produced through fully one half of their length from the point.

Mr. A. De Mari exhibits a very similar collection to that last mentioned.

The Osterby and Strömbacka Iron Works show a very extensive assortment of bar iron and wire, with the ores; and the Lesjöfors Iron and Steel Works make a similar exhibit, including an extensive assortment of nails, as do also the Degerfors Company.

The Saxa Iron Works make another of those excellent and convincing exhibitions, in shape of a set of specimens of Swedish iron, showing the results upon them of test strains of every kind. Such is the extraordinary ductility of this iron as exhibited in some of the specimens, that the section has suffered a reduction under tensile strain, before rupture occurs, to not more than ¼ that of the original section. The data accompanying these specimens are such as to give opportunity for exhaustive determination of the character of the iron. This is the true way to exhibit such products, and these gentlemen, as well as the Fagersta Company, are to be congratulated upon their display and the care and pains taken to inform the world as to the true character of their productions.

Of all the establishments included in this special feature of the Swedish section, the Motala Iron Works make the most extensive display. They have erected an immense column of bar iron and steel, which can be seen towering above every thing in the vicinity. Their exhibit includes products of Siemens-Martin and Bessemer steels and puddled irons. Among the separate articles shown is one of the finest specimens of flanged boiler-work the writer has ever seen. It is of Siemens-Martin steel plate, and is constructed from a single sheet some 5 by 12 feet dimensions. It constitutes a boiler front, with edges and furnace openings all flanged in. The work is done in a most masterly manner, and the original thickness of the plate is rigidly preserved in every part of every flange. They also show other specimens of similar work from Bessemer steel and puddled iron, all as perfectly done as the first-mentioned. Their exhibit also includes an exceedingly extensive assortment of other objects pertaining to machinery and iron producing and manipulating establishments, including the ores.

There certainly is no one special exhibit to be found within the Centennial inclosure which will better repay the engineer for time spent in a careful and thorough examination of it, than in this part of the Swedish Section of the Main Hall.

J. T. H.

THE INTERNATIONAL EXHIBITION OF 1876.

STEAM ENGINES.

No. 10.

CHARLES P. GLADIVIN, of Philadelphia, has on exhibition several of the quite well known "Supplee" engines, one of 25 horse-power, and two larger ones in Machinery Hall, besides one of 25 horse-power driving the machinery in Campbell's Printing-Press Building. There is nothing novel claimed for them, but they are offered in competition as substantial, well-made, and cheap specimens of the plain slide-valve "throttling" engine.

Legrove & Co. exhibit a semi-portable engine with vertical boiler. The horizontal cylinder is attached to one corner of a square casting forming the base piece of the boiler, and the main bearing to the other corner, in such a way as to be decidedly suggestive of weakness. The character of this machine throughout has the appearance of a sacrifice of essentials to cheapness. The painting of it also is done, as is true with too many builders of machinery, in a way such as to give to the whole work a tawdry appearance.

There is no one feature of the machinery at the Exhibition which is more decidedly indicative of the character of the work than the manner in which it is painted. The observing engineer will, at this day, be tempted to decide without further examination that a highly colored and fancifully ornamented piece of machinery is good in the inverse ratio of the degree of color and ornament. In the case of the machine under consideration, the shell of the boiler is painted a bright blue, the base and parts of the engine a kind of maroon, the uptake and pipe black, and the rivet-heads bronzed; a combination, than which nothing could be more inappropriate or in worse taste in a piece of machinery.

Theodore E. Winebrener, of Philadelphia, shows two sizes of Mitchell's vertical engine, which are in many respects desirable machines. The hollow box column, to one side of which the cylinder is attached, is an excellent design, and simplicity itself. Proper regard is had by this builder for that very vital consideration where economy of steam is attempted, and which is so largely neglected by manufacturers of the steam-engine—a reduction of the clearance and steam port or nozzle space to a minimum; the connecting-rod, however, in this machine is much too short, and an increase in the whole length and weight of the machine would be fully warranted, in order to give greater length to the connecting-rod and thus a longer life to the engine.

Among the exhibitors of the stationary engine, the Buckeye Engine Company, of Salem, Ohio, will occupy a very prominent place. They present three engines—one an automatic cut-off engine driving a section of the line-shafting, and a small high-speed saw-mill engine, with slide-valve, both in Machinery Hall; and a 12 x 18 in. slide-valve, or "throttling" engine, driving the line shaft in Annexe No. 3. In the first and last of these the Corliss bed is used in a somewhat modified form, and in the other an excellent form of box-frame is used. The castings in all these machines are among the very finest specimens of that kind of work to be found in the Exhibition, while it is no exaggeration to say that the workmanship upon them is equal, and the finish superior, to anything in the form of a steam-engine at the Exhibition. The engineer will, too, look in vain for anything like a radical defect in design with reference either to distribution of material, applicability of device, or accessibility of parts. Every part of these machines bears the impress of a mechanic mind, and one sees at a glance that the establishment which can produce such machinery must have men at the helm who are masters of their business.

The automatic cut-off mechanism of these builders is also a contrivance of a sterling and thoroughly mechanical character. It consists of a hollow box slide-valve, balanced by exclusion of steam pressure from its back; upon an inner face of the bottom of this valve slides an auxiliary valve, the rod of the latter passing through a stuffing-box formed in the hollow stem of the main valve. The ports are at the extreme ends of the cylinder and valve, thus reducing the port volume to the least possible amount. Motion is given to the main valve by an eccentric through the intervention of the usual rocking-arm working on a pivot attached to the engine frame. At about the centre of the length of this arm a rock-shaft is inserted, which at one end is operated by the rod from a second eccentric, and at the other end is a short arm, which imparts motion to the cut-off valve. The position of the cut-off eccentric on the shaft is varied by means of a pair of weighted levers, the centrifugal force of which weights acts against springs, the weights being adjustable upon the levers for different set speeds of the engine, and the whole being contained in a rimmed disc on the main shaft; this arrangement of weights, springs, and levers making a very effective and powerful governor. The effect of changing the position of the cut-off eccentric upon the shaft is to make the necessary changes in both the time and extent of motion of the cut-off valve, and thus arrest the flow of steam to the cylinder at points decided by the load upon the engine. It would be difficult to find anything more thoroughly good and mechanical in design and conception than this whole arrangement, and it reflects the highest credit upon its authors. The indicator diagrams taken from the engine show the action of this cut-off to be excellent, and that, when working at or near the most economic grade of expansion, an indicated horse-power is obtained from less than 19 lbs. of water per hour. These engines have an extremely small amount of clearance and steam-port space, and are all run at high speeds of piston. In point of fact, all the well-known factors in the economic use of steam have been given full value in the production of the "Buckeye engine." This cut-off is known as "Thompson's," and has been in use about six years.

A quite ingenious and simple way of oiling the crank-pin is attached to the engine. Bolted to the outer collar of the pin is a tube whose length equals the distance from the centre of pin to centre of the shaft; and it lies exactly in the place of a radius of the circle described by the centre of the crank-pin, so that one end travels around with the crank-pin and the other remains at rest. The extremity attached to the pin is made to communicate with a small channel or passage to lead the oil to the journal, while the still end is closed with a brass ball having a small opening leading in direction of the axis of the shaft into the interior of the tube. The position of this opening corresponds exactly to the centre of the shaft, and is therefore simply a round hole revolving upon its centre, into which the ordinary oil-feeder may be inserted, and oil injected into the tube while the engine is in motion; and the centrifugal action of the moving end throws the oil out to, and keeps it at, the crank-pin end while the engine is running. The only objection to it which can be urged is that if the engine be stopped with the crank-pin above the centres the oil remaining in the tube would run out. Like all the best machinery in the hall, these engines are painted that "dead surface," dark slate color, which contrasts so well with the very excellent finish of the "bright" work, and in every respect they do credit, not only to Western manufactures, but to the whole country.

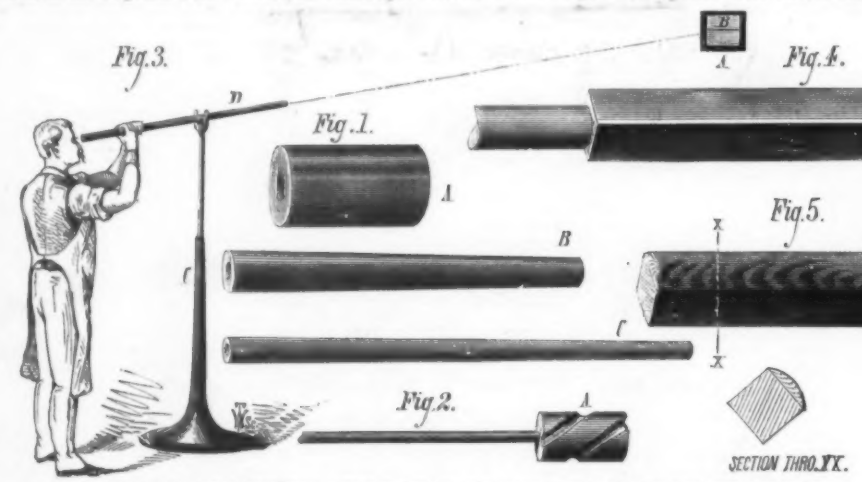
Another most excellent exhibit in this line is made by the Haskins Steam-Engine Company, of Fitchburg, Mass. The aim of this firm has been "to make a vertical engine which shall be as good in every respect as the horizontal type," with all the advantages known to attach to the former. Like almost all builders of the vertical stationary engine, however, they make the connecting-rod too short to render the equality possible. This oversight, more than anything else, has hitherto rendered the vertical engine for stationary purposes inferior to the horizontal. In every other respect these machines are all that could be desired, and do great credit to the designers and manufacturers. The frame is the well-known hollow column with sides cut away for access to the working parts, and is of most admirable proportion. The valves are the well-known Davis' piston or balanced kind, and operate to cut off the steam at from two thirds to three fourths of the stroke. The piston-rod cross-head, valve-rod and stem, and the crank shaft are all of steel, and the workmanship and finish are exceptionally good. The system of standard dimensions and form, which renders the duplication of parts always available, is fully carried out in their manufacture. There are seven styles of the engine: The semi-portable, with vertical boiler and feed-heater, complete upon one bed-piece; the engine on independent bed with crank shaft, and the same style with disc crank, and shaft extending in one direction only; the steam yacht engine with reversing motion by means of the stationary link, and several modifications of these.

The builders say: "We have, so far as possible, so constructed our engines that the strains are met by straight lines—curves being regarded by us, when in the direction of strains, as elements of weakness;" good sound philosophy, which they have certainly exemplified in all their designs.

In order to exhibit one of their machines in motion (being situated unfavorably with reference to the steam pipe) they run one of their larger engines backward by belting from the line-shaft, thus using it as an air-compressor, and drive the smaller engine with this compressed air; quite a novel way of overcoming the difficulties of their situation. J. T. H.

THE U. S. BUILDING IN THE CENTENNIAL EXHIBITION.—THE MANUFACTURE OF FIRE-ARMS.

THE manufacture of rifle-barrels is one involving a great deal of skill and delicate manipulation, for the reason that the length of the bore is so great in proportion to its diameter that the boring appliance, whether drill-reamer or bit, is exceedingly liable to spring, and will consequently, to some extent, follow the inaccuracies of the hole, even under the most careful manipulation, and with the very best of tools and machines. To obviate this difficulty has been the aim of many inventors, the most prominent among which is probably the hydraulic cold steel-drawing process, invented in France and developed in England during 1866. In this process, ingots of cold steel were forced by hydraulic pressure through dies, and the specimens of barrels and tubes examined by the writer at the company's works were marvels of fine finish and workmanship. The specimens consisted of round, square, oval, and triangular tubes of various sizes, and some of them were not above ⅛ inch diameter, the thickness of metal at the sides being from $\frac{1}{32}$ inch to ⅛ inch, and the lengths varying from a foot to three feet long. It was this company which demonstrated that cold steel could be thoroughly and completely welded by the two pieces being forced together under an enormous hydraulic pressure.



THE INTERNATIONAL EXHIBITION OF 1876.—FIRE-ARM MANUFACTURE.

In the United States, the main direction of effort appears to have been in various devices, whereby the boring tool or bar would be made to perform its duty while under tension, which would tend to resist the effort of the tool in following the contour of the work from springing out of the straight line. Whatever the degree of success to which this latter effort may have attained, based, as it undoubtedly is, upon correct main principles, certain it is that we have been obliged to fall back upon the human eye, a hand-hammer, and a straightening anvil as the most delicate and correct gauges wherewith to straighten a rifle-bore. It looks absurd, it is true, to see an artisan in this day looking through a rifle-barrel with the naked eye, and, laying it across two blocks of iron, strike it with a blacksmith's hand-hammer to make the bore *dead true*. As we proceed, however, we shall find that it is a very minute and precise operation.

The steel of which the rifle-barrels are made is imported from England in the form of what are known as barrel-moulds, shown in our engraving at A. These moulds are passed through eight successive rollings, our engraving showing at B and C stages of the process.

The rolling process completed, the next operation is to straighten the barrel on the outside, which is done by hand and by the eye; which being done, the boring process commences, the first one being termed the nut-boring, which is performed as follows: The boring rod or tool consists of a long rod of steel, sufficiently small and long to pass through the hole in the rifle-barrel; on the end of this rod is an enlarged piece about an inch in length, the cutting edges being at the shoulder, as shown in Fig. 2 at A; the operation is to pass the rod through the rifle-barrel and bore, by the revolving tool being pulled and not pushed by the feeding motion. It is obvious that if the resistance to the cut, or the strain caused by the cut, is in a direction tending to compress the metal of the boring-rod, that rod will spring and bend from the resistance; whereas, if the strain is a tensile one, the whole strain due to the cut will tend to keep the boring-rod straight and true, and prevent it from springing, no matter how heavy the cut may be; and these are the considerations which, applied to saw-teeth, induce the Japanese to cut their saw-teeth so that they operate while being pulled towards, and not pushed from, the operator. After the first boring, the rifle-barrel is again bored with another tool similar in every respect, save that it is of larger diameter. The next operation is to straighten the bore, which is performed as follows:

A is a frame containing a plate of ground glass, across which is placed horizontally the small, dark-colored bar B, the frame being placed in such a position that daylight shines directly through it; at about forty feet distance stands the rest C, whose purpose is to support one end of the rifle-barrel

D D, while the operator ranges the other end direct to the horizontal bar B. When the operator adjusts the barrel so that the light shines through the ground glass in a straight line through the rifle-barrel, the bar B will throw a dark line along each side of the rifle-bore for a distance, commencing at the end farthest from the operator's eye, about three fourths the length of the bore. (The rest of the bore appears from end to end like broad rings of light.) It is the straightness of these lines which is a guide to test the straightness of the bore. If there is the least waver, the barrel is not straight; but here arises the difficulty—in that, to see the waver inside is a very easy matter, but to locate it on the outside requires such correctness and judgment of vision that not more than one man in ten who essay to learn the business ever attain proficiency. It is necessary to revolve the barrel, so that the dark line shall strike all parts of the barrel, which must also be turned end for end in the rest C, because, as stated, the dark lines do not extend from end to end of the barrel. When the location of the bend is determined, the barrel is laid across an iron anvil or block, on which there are two projecting blocks, about eight to ten inches apart, and the straightening is performed with an ordinary blacksmith's hammer. After the first straightening, a collar of Babbitt metal is run on the outside and in the centre of the length of the barrel, which collar is faced up true, and used in a steady rest to prevent the barrel from springing while the roughing cuts are being taken off the outside in the lathe; it would be quite useless to finish the bore before the outside was turned, because the latter operation, from releasing the tension on the outside of the metal, the inside would get out of true again. After the first outside turning has been performed, the barrel is again bored, this time with a square reamer, such as shown in Fig. 4, revolved at a somewhat quick speed, and fed first forward and then backward and forward somewhat rapidly.

The next operation is to repeat the straightening process, and then the outside is again turned, and the boring process repeated, the same square reamer being used with a piece of wood placed on one square, as shown in Fig. 5, which piece of wood steadies the reamer, as well as causing it to cut a slightly larger bore, by reason of fitting a little tight in the rifle-bore. After this boring, the outside of the barrel is ground on a quick-running stone, and the straightening and boring processes are repeated, slips of paper being placed under the piece of wood (shown on the square reamer in Fig. 4), so as to increase the size of the bore until it becomes of the correct, plug-gauge size. Here we may note that the dark lines thrown on the inside of the bore by the horizontal bar B in the frame A, in Fig. 3, magnify any defect in the bore, and that, as the operatives express it, the wave in the barrel never appears to be where it actually is; and hence the difficulty of locating the defect on the outside of the barrel. The polishing of the barrel outside is performed as follows: The barrel is held vertically, and revolved while being passed down between the end faces of two pieces of wood, upon which emery has been glued in the same manner as an ordinary wooden-polishing emery-wheel. After the first polishing process, however, the barrel is not made to revolve, but is moved vertically back and forth between the pieces of wood, so as to leave the polishing marks straight lengthwise of the barrel. The first polishing is performed with a grade of emery about No. 60; the last is done with flour emery. The machine in which the polishing is performed holds five barrels at once, the polishing woods opening and closing as the barrel passes through them, so as to accommodate the taper.

After the barrels are sighted, they are rifled. The machine employed for this purpose in the Government Building is one that performs and finishes the operation without having to lap the grooves afterwards, as is the case with other rifling machines. In the machine in question, the bed is similar to an ordinary lathe-bed, the rifle-barrel being held in a stationary head at one end of the bed; to this head is attached suitable gearing, by which the barrel is made to suddenly make one third of a revolution. The cutter mandril—or rifling-rod—is held by a carriage travelling along the machine-bed, and operated back and forth by chain-gear. The cutters for rifling are arranged on the end of the rod in three groups, there being two cutters in each group. The width of the cutters is such that the rifle-grooves are of the same width as the spaces between them. At the end of the stroke, the rifling-rod also makes a one-third revolution, but in a direction opposite to that in which the barrel moves when partly revolved; so that each set of cutters cut first in one groove and then in another, by which means the rifling is performed more true than would be the case if the same cutters always ran in the same groove. The cutting is performed on the stroke in which the rifling-rod is being pulled through the rifle-bore, and does not operate when being pushed, because a tensile strain tends to keep the rod straight, while a compressing one would inevitably spring and bend the rod.

The cutters are ranged so that their cutting edges stand at a right angle to the rifle-groove, and not to the bore of the barrel. They are not in reality cutters, but scrapers, their cutting edges being formed by two angular faces of exactly the same form as the scraping tool shown on page 225 of the SCIENTIFIC AMERICAN SUPPLEMENT, which performs its duty evenly and smoothly, and is very easily sharpened. The cutters are expanded as the rifling proceeds by a cone attachment applied to the bar, the feed-motion being on the sliding carriage. When, however, the rifle-grooves have been cut sufficiently deep, which is determined by the amount of the expansion of the cutters, an automatic arrangement, which is very simple in its construction, throws the cutters back to their smallest diameter, and the process ceases. During the whole of the boring and rifling processes, the bore of the barrel is liberally supplied with oil, the tools being tempered to a light straw color. The time occupied in rifling a barrel is about an hour. At the Centennial, however, a longer period is taken, on account of the time occupied by the attendant, Mr. Addison Stone, in answering the many questions which these interesting operations lead the crowd of visitors to make.

THE JAPANESE AT THE CENTENNIAL.

No one feature in the whole of the history of the Centennial Exhibition has become more prominent from a practical-mechanical point of view, than the operations and specimen, of handicraft exhibited to us by the Japanese workmen. That they drove their piles by hand in the first place, and that their tools performed the cutting during a pulling and not a pushing stroke, as they should do according to our philosophy, caused a smile among our artisans. As time progressed, however, and the quality of their workmanship became visible, the smile vanished. The first question asked by mechanics on the grounds was, "Have you seen the work of the Japanese at their building?" The visitors around the building underwent a transformation: the former vast majority of curiosity seekers became a majority of intelligent artisans, and the SCIENTIFIC AMERICAN SUPPLEMENT sent a representative to look into the matter; the result being the engravings and descriptions of their tools which have from time to time appeared in our paper. Since the opening of the Exhibition this peculiar people have given us still further cause for admiration, wonder, and respect by displaying specimens of handicraft, whose excellence and overwhelming superiority is so great that we have nothing sufficiently excellent to enable us to make even a comparison; so that it may be said that as specimens of metallurgical skill the Japanese bronzes stand first, and there is no second or third, the rest being behind and in a heap.

There is now being erected a Japanese museum, whose contents are, we are informed, to be as interesting as all their other operations and exhibits have, so far, been. The Japanese gardeners are busy at work at the garden surrounding their government building and that around the new museum, which gardens are to be filled with plants indigenous to Japan, promising us, therefore, a fine floral display.

THE JAPANESE SAWS.

Upon a recent visit we were allowed an opportunity to test practically the mooted questions, "Will the Japanese saws cut both ways? How can such a thing be done?" We answer that it is done; that we had the pleasure of sawing a board through while handling the saw so that its teeth only had contact with the board during the pushing stroke, and then sawing another board through while handling the teeth so that they only had contact with the board while being pulled through it; and the result was that the saw cut both ways, but the cutting was more rapid during the pulling stroke, which arose from the direction in which the teeth stood. Our third operation was to cut a board while the saw cut on each stroke; and, finding that also satisfactory, we minutely examined the form of the saw-teeth, and are now enabled to lay the whole question before our readers.

To proceed intelligently, we must first understand the principles governing the shapes and forms of saw-teeth, the directions of the strains, and the effects of the same. The strain on the face of any cutting tool is at a right angle to the face which meets the cut; hence the angle, whatever amount there be, across the thickness of the tooth tends to throw the teeth sideways, as shown in Fig. 1 in our illustration; and,

Fig. 1.

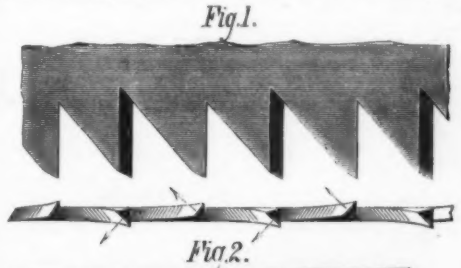
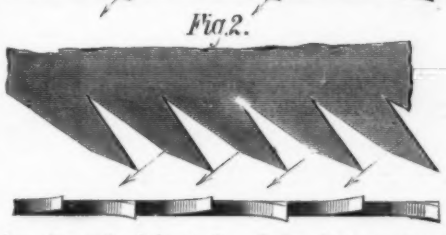


Fig. 2.



unless the angle of the teeth and the sharpness of every tooth in the saw be equal, the strain will be greater upon some teeth than upon others, and hence the spring will be more, and the work will be performed proportionally uneven. even supposing the teeth required no set. When, however, we take the set into account, we have a new element of discord, because if any teeth have the least more set in them than have the majority of the teeth, they receive vastly more strain, and spring the saw; especially is this the case where two or three adjacent teeth have an excess of set, or where a single tooth has so much set as to relieve the teeth immediately behind it of duty. If, to obviate this, we were to give the saw-teeth no cross bevel, but a radial bevel (as shown in Fig. 2 in our illustration), the strain would be placed in the direction of the arrows in that figure; which would not tend so much to spring the saw sideways, it is true, but here we encounter a new difficulty, in that the latter will not clear itself in the wood, and the cuttings clog in it, even though the set of the teeth be made more than is common. The reason for this is plain enough. Suppose, for instance, we take a carpenter's chisel and cut across its whole length; the groove it will plough will have a ragged and fibrous edge, and to produce a smooth one we must cut a line along each side of the intended groove, and this is just what the side bevel shown on the saw-teeth in Fig. 1 does. The form of tooth illustrated in Fig. 2 may be used in a circular saw in which the teeth are far apart, and in which, from the teeth being inserted, there is given to it sufficient clearance on the sides (as shown in Fig. 3) to enable it to clear itself and cut freely; but in the case of hand-saws, to which our remarks have more particular reference, the clearance on the sides can only be given by the saw-set, and the setting can not be quite evenly performed; whereas, inserted saw-teeth can easily be made all of one thickness and kept so with proper management. Then, again, the teeth of hand-saws are so close together that ample clearance is of the utmost importance. Upon examining closely the shapes of the teeth shown in Figs. 1 and 2, we shall see that the extreme point of one strikes a line on each side of the cut, and only as the teeth enter the wood deeper is the cutting removed—the principle being somewhat after that shown in the teeth in Fig. 4, which will cut both ways, for the reason that the edges of the teeth are formed by similar angles back and front. The action of this saw is to cut clean on each side of the saw-cut and remove rather than cut away the centre—the points of the teeth being very keen, and the keenness disappearing as the gum of the tooth is approached.

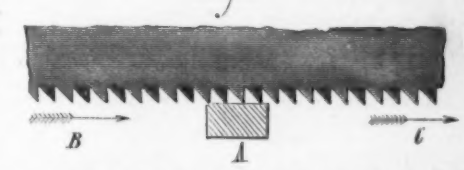
Fig. 3.

The shape of the teeth in Fig. 4 gives ample clearance, it is true, to the cuttings, and is a form of tooth very easily re sharpened. It is more applicable, however, to large than to small saws, and is here introduced to illustrate the principles governing the cutting qualifications of various shaped teeth.

We now come to another consideration—that is, the spring of the saw due to the resistance of the cut. Suppose that with the saw shown in Fig. 5 we were required to cut the piece of wood A, and that we work the saw, applying the power in the direction of the arrow B, pushing it to its cut. It will readily be seen that the resistance offered by the cut to the teeth tends to cause the saw-blade, from the teeth in

Fig. 4.

Fig. 5.

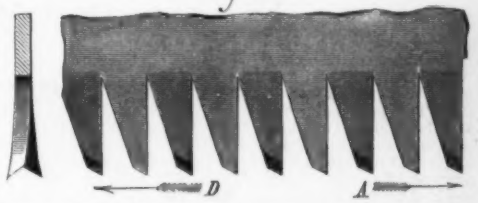


operation to the end of the saw where the power is applied, to bend or spring bodily; whereas, if the power were applied at and in the direction of the arrow C, the strain due to the resistance of the cut would tend to straighten the saw, and would offer a resistance to any bending of the saw-blade which might tend to arise by reason of the bevel of the front of the teeth, or of an inequality of the amount of the set of the teeth. If we take a very narrow saw-blade, we shall find that while it will buckle and bend if pushed to its duty, it will cut without bending if pulled.

We now come to the Japanese form of saw-tooth shown in Fig. 5—the size of the teeth being enlarged, as in the case of Figs. 1 and 2, for the purpose of distinct illustration.

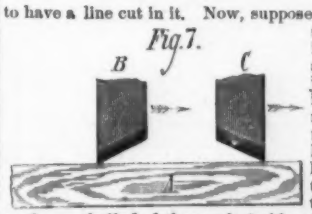
First, then, we find that the front face of the tooth is at a right angle to the side faces; hence there is no tendency on account of the angle of that face to spring the teeth sideways, as is the case when the front face of the teeth have bevel, as shown in the edge view of Fig. 1. Next we find that the teeth possess the advantages possessed in the teeth shown in Fig. 4, inasmuch as that the points of the teeth cut a line on each side of the saw-groove in advance of removing the cuttings, thus relieving the teeth of much duty, and preventing the cuttings from binding, as may be clearly understood when we consider how much easier a chisel will cut a groove when we have run the chisel edge along each side of the groove before attempting to cut the wood out. We next observe that, to sharpen the teeth, we have only their end faces to file, and that they are very easily got at. And finally, we come to the question of cutting both ways. From our previous remarks it will be seen that for cutting in the direction of the arrow A, in Fig. 5, the teeth possess the combined advantages of the form of teeth shown in Figs. 1, 2, and 4, without possessing their defects. Now, when the teeth are travelling in the direction of the arrow D, in Fig. 5, they are acting upon the principle on which the saw in Fig. 4 works—that is, the edge of the point is cutting a deep line on each side of the saw-groove, and the front edge of the teeth removes rather than cuts the wood thus already severed on each side from the main body. That the shape of the tooth is admirably adapted to this duty, will be perceived on reference to Fig. 6, in which A represents a piece of wood requiring

Fig. 6.



to have a line cut in it. Now, suppose we hold the chisel as shown at C, moving it in the direction of the arrow, it will dig in and jump; but if we hold it as at B, and still move it in the same direction, it will cut easily, smoothly, and freely. Now if we apply this consideration to the Japanese hand-saw teeth, we shall find them admirably adapted to the purpose. It is not to be presumed that the cut on the back stroke would in the case of hard wood be of itself very effective—that is to say, would cut freely if the teeth only contacted with the wood on the back stroke, but in cutting a line on each side of the saw-groove during the back stroke, and thus assisting and relieving the cutting of the front stroke, the Japanese shape of tooth is, even for use upon very hard wood, admirably effective. As far as the question of pulling *versus* pushing the hand-saw goes, it is undoubted that pulling it will produce the finest work, but not near so much force can be applied to it; hence we believe it to be a slower operation, and one which with the excellent finishing tools we have, it is inadvisable to copy. But for such delicate work as the Japanese perform, pulling is absolutely necessary, and it is safe to say that in producing fine work by hand-labor, the Japanese have but little, if any thing, to learn from us, although we can "show them a thing or two" when it comes to producing a large quantity of ordinary or utilitarian work. It may be here noted that the Japanese workmen have purchased quite a quantity of saws in this country, but the blades were blanks—the Japanese foreman saying that the teeth must be cut in Yokohama, so that they may be sure to be cut to their form. There is yet one more consideration, however, which is deserving of notice: that is, that the correctness of the principles upon which the Japanese saw-teeth are formed and used enables them to use blades much thinner than is practicable with our saws, thus saving material in both the saw and the work, as well as facilitating the re-sharpening of the teeth.

Fig. 7.



SEWING-MACHINES AT THE EXHIBITION.

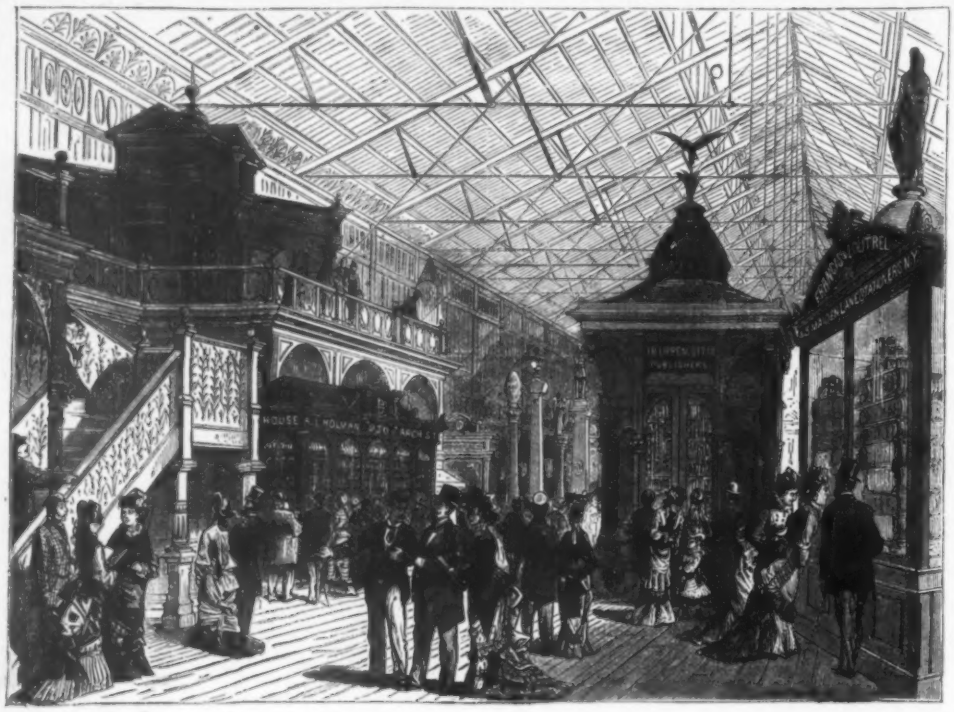
In close proximity to the great Corliss engine is the sewing-machine department, which is very generally represented by creditable exhibits. Prominent among these is the display of the Wheeler & Wilson Company. They show a large number of machines in every variety of case and style, from the heaviest manufacturing to the lightest for household use. They seem to have kept in mind, in making up their exhibit, the practical utility of the sewing-machine, for, while many of the machines are very rich and elegant, they are all noticeable for a simplicity of ornamentation which belongs to an article designed for actual use. The cases are all solid and substantial rather than ornate, and heavy with carving; and the machines in their dress of black and nickel or gold are well calculated for the wear and tear of constant work. There has been much good taste shown in the preparation of this exhibit. The specimens of work displayed in handsome cases cover every variety from the daintiest embroideries to the sewed work of shoes, saddles, harness, and the heaviest leathers.

The Domestic Sewing-Machine Company's exhibit is arranged with artistic taste, and is an ornament to the department. The "Domestic" is a light-running, noiseless machine, distinguished for the following points: When tension is adjusted properly for two thicknesses of cloth it will answer for twenty. In every place where the chance for lost motion occurs it is taken up, as it has conical bearings on all points. The leather machine makes a very handsome pearl-stitch for fine work, and can carry heavier tension on upper thread without breaking than any other machine.

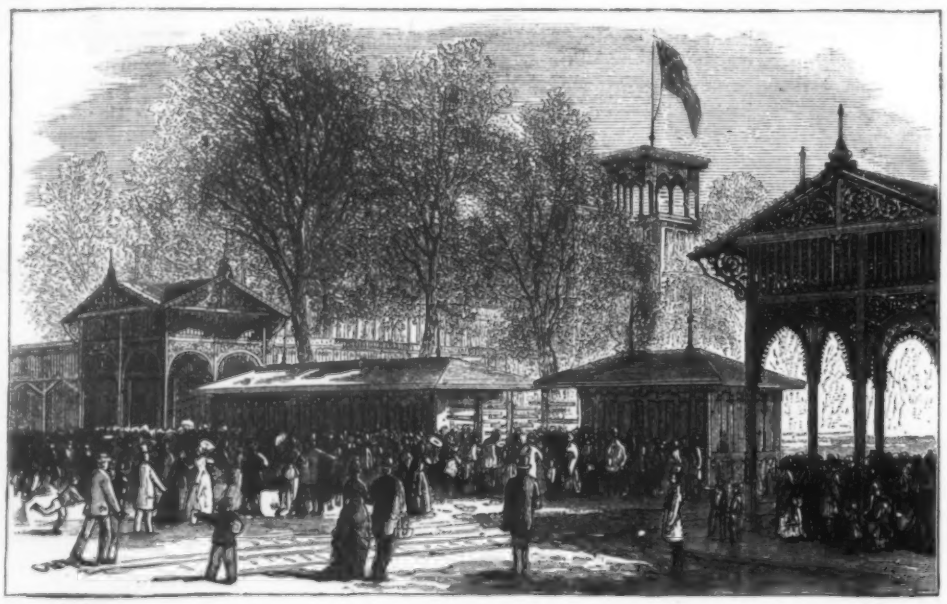
The Home Sewing-Machine exhibit of Johnson, Clark & Co. exhibits in a very elegant pavilion of solid walnut, elaborate with carving and surmounted with a dome bearing a carved statue of the "Angel of Peace." The display of machines is numerous, embracing all the styles of this make, and beautifully plated and polished.

ENGLISH SEWING-MACHINES.

The space occupied by Kimball & Morton is commodious, and well filled with the various machines of their manufacture. The principal sewing-machine which is exhibited here is the left and right hand overhead machine, adapted for sails. It adds greatly to the strength of the material, and, it is said, will accomplish the work of twelve sail-makers. This machine secures both the straight and the "herring-bone" stitch. In this display there are sixty other machines, comprising the smallest hand machines as well as the largest for sail-sewing.



THE INTERNATIONAL EXHIBITION OF 1876.—THE AMERICAN BOOK EXHIBIT.



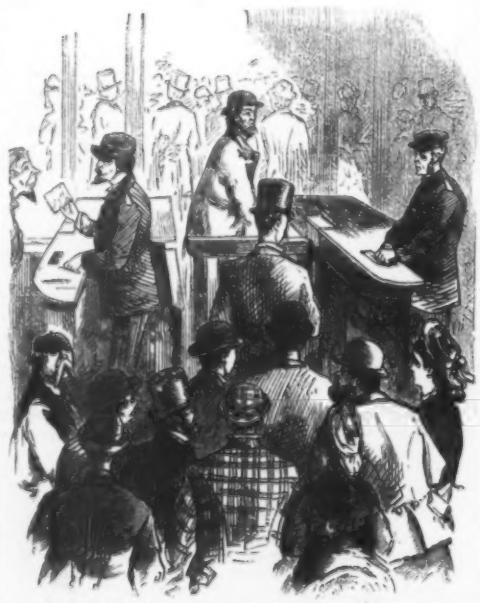
THE INTERNATIONAL EXHIBITION OF 1876.—THE ENTRANCES.

THE AMERICAN BOOK EXHIBIT AT THE EXHIBITION.

THE American Book Association conceived and successfully executed an artistic and novel design for displaying books of science, art, or literature, published in the United States. Instead of arranging that each firm should exhibit in a separate show-case, as is done by exhibitors of all other interests in the Main Building, the Association constructed, in the south-eastern corner of the building, an elegant platform about seventy-five feet in length and thirty in width, from which arise iron pillars, supporting a second floor, corresponding in every respect with the one below. The construction of the iron stairways ascending to the second floor is extremely elaborate, as is also that of the show-cases on each floor. The whole is divided into as many sections as there are exhibitors in the Association, at the top of each section being the name of the exhibitor in chaste gilt letters. Most of the leading book firms in each city of the United States are represented. —*Frank Leslie's Newspaper.*

ENTRANCES AND MECHANICAL DOOR-CLERKS AT THE EXHIBITION.

As nearly as possible the work of keeping the accounts of the number and class of visitors at the Exhibition is done by machinery. The entrances are covered by porch roofs; each passage-way is narrow, just wide enough to permit visitors to pass in single file. Across the entrance stand the arms of a pivoted turnstile, as shown in our sketches, which are from *Harper's Weekly*. An attendant takes the money, consisting of a fifty-cent silver or paper piece, places it in the money-box slip, and motions the visitor to enter; he presses against the stile-bar, which rotates, and in so doing operates a system of concealed number-wheels, which register and add up the revolutions of the stile. At the close of the day the dials of the apparatus show exactly how many persons have passed in, and the money-receiver is required to return the money therefor to the Treasurer.



MECHANICAL CLERKS AT THE EXHIBITION ENTRANCES.

TORPEDOES AT THE EXHIBITION.

In our SUPPLEMENT number we presented some illustrations of the Lay Torpedo, as practically tried at Washington. This ingenious implement of warfare forms a conspicuous and interesting exhibit in the United States Government Building at the Exhibition. The following particulars we find in the *Public Ledger*:—

The torpedo is a machine for destroying hostile shipping, pontoon bridges, etc., through the agency of subaqueous explosions. The germ of the device is to be found in floating powder vessels, which were first used at the siege of Antwerp in 1585, but the name "torpedo" was first applied to the machine by Robert Fulton about the year 1800. Fulton's system included four classes of torpedoes: Buoyant mines, held in place by anchors, and provided with a mechanical device by which explosion ensued when they were struck by a vessel; line torpedoes, exploding by clockwork; harpoon torpedoes, to be attached to the enemy's vessel by a harpoon shot from a gun, and then to be exploded by clockwork; and lastly, "blockship" torpedoes, to be carried on spars projecting from a peculiar kind of vessel, and exploded by contact with the enemy. Now we will examine those on exhibition in the Government Building, and see what novelties, if any, or improvements have been made in this direction during seventy-six years.

The collection is divided into three distinct classes, namely, the movable or automatic, towing and spar torpedoes. There are three specimens of the movable class, the Lay, Ericsson, and the Fish, of which the most perfect and important is the Lay. The motive power of this is carbonic-acid gas, and the machinery is governed and the helm is steered by electricity. It explodes, however, by contact only, with three percussion fuses on the head. The head or nose of the torpedo contains the explosive charge of 300 pounds of powder, or 75 pounds of dynamite. In the second section of the interior are three flasks, containing the carbonic acid which generates the gas, and a tube carries the gas from this to the machinery at the other end. The third or middle section contains a roll of two miles of wire which pays out from the torpedo itself; in the fourth or last section is the engine or steering apparatus. When experimenting with it recently at the torpedo station, Newport, R. I., they sent it out to sea for one mile and a half, thus proving it to be the best and most successful ever made. While running out, the torpedo is submerged several feet, but its course is traced by small guide-poles and flags thereon, and it is steered or stopped by the electrical connections on the shore.

The next is an Ericsson torpedo, of which the motive power is pneumatic pressure. The nose part contains the charge of two hundred pounds of powder. There are diving fins, to regulate the depth of submersion, and the machinery is all inside. The peculiarity of the power of propulsion is in two screws—one having a direct and the other a back action—revolving in opposite directions and giving the propelling power ahead, while the rear propeller neutralizes the "back-lash" of the other on the rudder. The engine for this is of course an air-pump, the air being forced through a pipe, to which is screwed the hose, and this is wound round a reel which pays out as the torpedo moves forward. The great objection to this is the weight and bulk of the engine and hose-carriage, and the torpedo can only be sent out a few hundred yards.

Next to this is the "fish" torpedo, the power of propulsion of which is 30 atmospheres. It has a revolving screw and fins to regulate the depth of submersion. It only explodes on contact; there is no means of steering it, but it is simply launched forward in the direction of the object of attack. If it should fail to strike it would continue in its course until the motive power was exhausted and would then sink. The towing torpedoes of Captain W. Harvey, of the British navy, are placed next, and explode by contact with a series of levers over a drop bolt. As these are supported in the water by cork buoys they explode very near the surface, and are hence objectionable.

The Barber torpedo is claimed to be an improvement on Harvey's. It is supported by fins, and explodes either by contact or electricity.

Several spar torpedoes are exhibited in like order. These are 100-pounders and 75-pounders, shown both closed and opened. In connection with this class is the model of a boat specially designed for them; the spar torpedoes attached and the method of using them is clearly shown. They are exploded by means of Farmer's dynamo-electric machine, of which several are exhibited, together with pneumatic batteries, circuit closers for submarine mines, torpedo fuses, whole and in section, and an electric pedestal and key-board by Lieutenant Bradford, U. S. N.

MICHIGAN APPLES

IN the Agricultural Department a fine exhibit of apples from Michigan has lately been given, which has attracted a good deal of attention, on account of the fresh appearance of the fruit. There were nearly 200 varieties, all as plump and

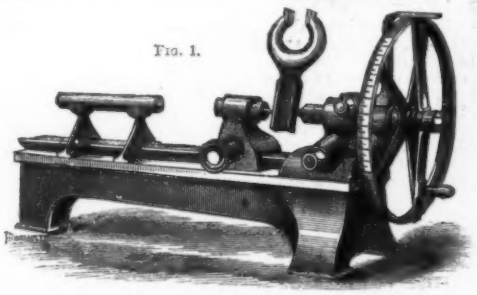
well-flavored as if just plucked from the tree. The fruit comes from an establishment in Battle Creek, where it is kept in a building in which, by thick walls and a steady draught of cold dry air, a uniform temperature, free from moisture, is secured. Apples are thus kept unimpaired for over two seasons. There is a similar preserving house on the Delaware, below Philadelphia, that is connected with the Michigan enterprise.

[Engineering.]

MEASURING MACHINE AT THE EXHIBITION.

AMONGST the exhibits shown at Philadelphia by the students of the Cornell University, at Ithaca, N. Y., is the measuring machine, of which we annex engravings, this machine having been constructed by the students in the workshop

FIG. 1.



THE CORNELL MEASURING MACHINE.

attached to the college, from the designs of Mr. John E. Sweet, the director. On a future occasion we shall have something to say on the whole collection of exhibits from the Cornell University, but for the present we shall confine our attention to the measuring machine we illustrate, a machine which we can not do better than describe in Mr. Sweet's own words, as follows:

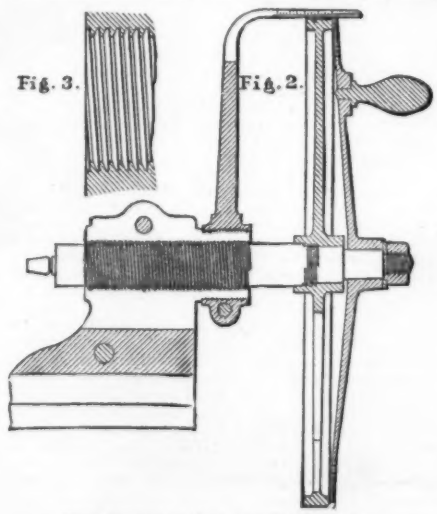
"Owing to the first cost of the Whitworth gauges, to avoid losing the true measure by wear, and owing to the inconvenience in using the ring for any thing but parallel shafts, most firms possessing them make solid calipers similar to the one shown in Fig. 1; only using thin forged steel instead of the thick cast steel cast into shape, as in the one shown. Believing that tools of this kind, if as accurate as the Whitworth gauges and of sufficient thickness to give them strength and durability, will serve the same purpose as the gauges and calipers together, and that they can be furnished at a cost which will be within the reach of all firms who attempt to do good work, I have thought we should be doing good service by fitting up the necessary machinery for their construction.

"The measuring machine shown in Figs. 1 and 2 measures from zero to 12 inches by the ten-thousandth of an inch, and possesses some points of merit. It will be noticed that the bed of the machine resembles the bed of a lathe on a small scale, except that it is supported on three legs cast in the same piece. The head-stock carries a micrometer screw having a pitch of 16 threads to the inch, the thread on the screw and the thread in the nut both being *of the same length*; this is to avoid the difficulty always occurring when a short nut is used on a long screw, that of the screw wearing loose in the centre, while it remains tight at the ends. The graduated wheel divided into 625 parts gives ten thousand subdivisions to the inch. Every tenth mark being longer than the others, and every hundredth longer still, enables the operator to read hundredths, thousandths, and ten thousandths as readily as would be possible by any arrangement; and the sixteenth pitch screw enables him to read the ordinary divisions of sixteenths, thirty-seconds, eighths, etc., more readily than could be done by any arrangement based on the decimal system.

"The crank by which the screw is turned is not fixed in

Fig. 3.

Fig. 2.



THE CORNELL MEASURING MACHINE.

the wheel, but to a friction-bar, and the friction regulated by a central nut; so that while there is friction enough to drive the screw, there is not so much but that the friction-bar will slip when the two 'feelers' come together or in contact with the work being measured. This arrangement prevents undue strain being put upon the machine; it does not prevent the machine from being used by the sense of touch, which Whitworth proved to be the most sensitive, and admits of the machine being used by direct contact, enabling two persons to arrive at the same reading, as the pressure put upon the work is governed by friction rather than by the strength of the operator.* To adjust the machine, instead of attempting to set the tail-stock so as to have the index point to zero on the wheel, the index is itself adjustable. Thus, if when the two feelers are brought together, and the index does not indicate as it should, it is adjusted by loosening the thumb-screw that holds it fast, allowing it to be turned forward or backward, correcting the reading readily. The index arm projecting over the wheel is graduated into the ordinary divisions of an inch, so that it is not necessary to count the revolutions of the wheel when more than a sixteenth is to be measured. The micrometer-screw has a travel of only a little more than one inch; so that when anything longer or larger than one inch and less than two inches is to be measured, the tail-stock is set back one inch, a standard gauge one inch in length is inserted between the feelers and the index adjusted to zero, as in the first instance. Standard gauges, of different lengths, varying by inches from one to eleven, make it equally convenient to measure all distances up to a foot, with this good feature: that the machine is always adjusted at the time of taking the measurement, and if the standards are of steel as well as the tools being measured, then any variation in the temperature will not affect the result, so that care is taken to allow both pieces to acquire the same temperature.

"The accuracy of the measurement, so far as explained, depends upon the accuracy of the standards, the accuracy of the screw, and the edge of the index where the reading is taken being parallel with the axis of the machine. Out of this last element grows one of the best features of the machine; for by cutting this edge at an angle instead of parallel the imperfection in the pitch of the screw is corrected to the greatest nicety. We have in fact corrected the error in the machine, and found it to be 1 in 4480."

* By the use of vulcanite and steel as friction surfaces, we are able to repeat the measurements any number of times and keep within a variation of one forty-thousandth of an inch.

THE *MEGATHERIUM CUVIERI* AT THE EXHIBITION.

AGRICULTURAL HALL.

AMONG the remarkable objects in the natural history department in Agricultural Hall, one of the most striking is the gigantic skeleton cast of the *megatherium cuvieri*, shown in our engraving, exhibited by Professor Ward, of Rochester, N. Y. Concerning this creature, Professor Ward says: The first fossil remains of this animal were discovered in 1789, near Buenos Ayres, and were first transmitted to Madrid in Spain. The original bones, of which this specimen is a copy, were found in the same pampean deposit between the years 1831 and 1838, and belong partly to the Hunterian Museum and partly to the British Museum. To give to this singular quadruped its proper position in the animal kingdom was, for many years, a problem in comparative anatomy which the savans of Europe could not solve. Led astray by the huge carapace of the glyptodon found near it, the majority called it a mammoth armadillo. Cuvier, who gave it its generic title, thought that it combined the characters of the sloth, ant-eater, and armadillo. The merit of throwing a flood of light on the structure and nature of this the most remarkable of all fossil animals, was reserved for the celebrated English geologist, Professor Owen, who conclusively proves that the megatherium was a ground sloth, feeding on the foliage of trees which it uprooted by its great strength.

The extreme length of the mounted skeleton is seventeen feet and nine inches; its height from the pedestal to the top of the spinous process of the first dorsal vertebra is seventeen feet. No other fossil so exceeds its modern representative as the lordly megatherium surpasses the pigmy remnant of the Tardigrade race. One is tempted to join the Spanish naturalist who objected to the place assigned to the megatherium because "all the other edentates could dance in his carcass." But that there is the closest affinity between it and the diminutive arboreal sloth, is now undeniable. The number of teeth, their deep insertion, equable breadth and thickness, deeply excavated base, inner structure and unlimited growth, and the absence of canines, are characters common to both. The part in which the megatherium least resembles the sloth is the tail; and, as a general rule, in those modifications of structure in which it differs from its living analogue it approximates to the ant-eater.

The head of the megatherium is remarkable for its relatively small size, for the extraordinary depth of the lower jaw, and for the great size of zygomatic process. The length of the skull is thirty inches—three inches less than the Asiatic elephant. The formation of the muzzle indicates the possession of a short proboscis.

The spinal column consists of seven cervical, sixteen dorsal, three lumbar, five sacral, and eighteen caudal vertebræ, and measures fifteen in length, or three feet more than the elephant's. The circumference of the skeleton at the eighth rib is eleven feet.

The megatherium differs strikingly from existing quadrupeds of corresponding bulk in the vast proportions of its anterior extremities. Its clavicle, fifteen inches long, is the longest known. The foreleg bespeaks enormous strength; with the foot it is seven feet and four inches in length.

The hind legs appear more like columns for support than organs for locomotion, and, with the hind feet, are models of massive organic masonry. The heel bone alone has the extraordinary length of seventeen inches and a circumference of twenty-eight inches. The monster walked like the ant-eater, on the outside edge of its foot, on a marginal hoof-like callosity. The middle toe of the hind foot and fourth digit of the fore foot were armed with powerful claws. The magnitude of the tail fills the observer with wonder. When clothed with flesh it must have been more than six feet around at the greater end. With the hind legs it formed a tripod, upon which the animal rested when obtaining its food. It would be interesting to know something of the daily life of the animal whose colossal size was united to such strange anatomy. As the brain of the megatherium was less by nearly one half than that of the elephant, we infer that he was a creature of fewer instincts. Nevertheless his cotemporary quadrupeds must have acknowledged him as the head of the animal kingdom. To the tongue of a giraffe and the proboscis of a tapir, there was added the power of rotating the bones of the fore-arm. These prehensile organs were suited to a leaf-feeder. That the animal was not carnivorous, is settled by the structure of its molar teeth; it lacks incisors, therefore it was not a ruminant. But if the great animal fed on foliage, how did it obtain it? The elephant gathers its food with a long proboscis. The giraffe, standing on stilt-like forelegs and reaching out its attenuated neck, plucks the high branches with long flexible lips and muscular tongue. The megatherium could imitate neither. The fore-arms were plainly formed for grasping, and not climbing or digging; they were instruments of tremendous strength, evidence of which is furnished by the deep grooves and sharp ridges on the radius and ulna, the starting-points of stout tendons and muscles. The moment we estimate this force, the colossal proportions of the hind extremities lose their anomaly, and harmonize with the front. The application of the fore-arms to the work of tearing down a tree would demand a corresponding fulcrum such as we find in the heavy pelvis, the ponderous tail, and the massive hind legs.

When stripping the trees it had prostrated, its position was probably a reclining one; and Professor Agassiz ventured the opinion that this crouching attitude was constant to the animal, and that it crept along with the full length of the fore-arm resting upon the ground.

The pampas, where the remains of the great fossils have been chiefly found, are vast plains stretching from the mountains of Brazil to Terra del Fuego. Palms grow at one end, while snow covers the other almost the entire year. The soil is chiefly a dull, reddish, slightly indurated argillaceous earth, with here and there calcareous concretions; underneath are beds of stratified gravel and conglomerate. These deposits constitute the pampean formation, which varies in depth from twenty to one hundred feet. They were slowly formed at a time when the Atlantic reached far westward to the foot of the central mountain chain, down whose banks the rivers brought the detritus, and spread it beneath the waters in level layers at some distance from the shore. Carcasses of animals floated down upon the same streams, and, reaching the quiet waters, sank down in their muddy bed. The whole area has since been elevated, the estuary mud has been converted into wide and level plains, and the shores and submarine banks of a former sea now form low headlands along the present coast. It was in this recent formation—referable to the Pleistocene period, because most of its shells are still living in the ocean—that the megatherium was entombed. Its bones are almost exclusively found in the cliffs and steep banks of rivers—thus far, the rivers Salado and Luxan. The race was not exterminated by some great cataclysm, for the small bones, like the knee-cap of a cotemporary mammal, were

THE *MEGATHERIUM CUVIERI* AT THE EXHIBITION.

discovered by Darwin in the same deposit, all lying in their proper relative position. Like the aborigines of our own continent, like the dodo of Mauritius, the edentate giants perished one after another, in the lapse of infinite ages, by those changes of circumstances in the organic and inorganic world which are always in progress.

THE JAPANESE BRONZES.

THE exhibit of the Empire of Japan contains those marvels of metallurgical art, the Japanese bronzes, arranged around the sides of a raised platform. At each side of the steps leading to the platform stands one of the two largest bronzes, the pair being of similar design and finish. We doubt whether the possibilities of metal work can be fully realized until these wonderful specimens of handicraft are inspected. The base of one of the vases is formed of rocks and trees in full leaf and bloom, each leaf and flower being complete in detail. Interspersed among the rocks are snakes and birds. Above the base are six elephants' heads with tusks. These are surrounded by a second base, as it were, on which are weird dragons and nondescript imaginative forms of animal life. Above the second base again are four statues of Japanese swordsmen, the attitudes and expressions on their faces being suggestive of extreme burlesque. Another tier of trees follows in full leaf and flower, interspersed with more weird-looking animals, whose completeness of detail and uniqueness of design are simply astonishing. The price set upon this pair of vases is $4000. Ranged around the platform are candlesticks, varying in price from $300 to $650 per pair, the designs of some being birds supporting the sockets. Among the urns are some of exquisite workmanship, and inlaid with silver and brass, the prices ranging from $300 to $4000, the latter being the price of an ornament for a temple. It is gratifying to know that at least some of these specimens are not to leave us, since many of them have been purchased by Americans. Professor Archer, however, of the British Commission, is the fortunate purchaser of the largest number and of some of the finest specimens. In addition to the bronze vases there are some of china, beautifully decorated, the price of one large pair being $2500.

THE BOHEMIAN GLASS.

This is a truly beautiful display, including glassware of almost every description, tint, and design. Some of the sets are of opal-glass, tinted blue or pink, with enamelled decorations in white. A dinner set of royal blue, with the centre-piece, fruit dish, and dessert dish of what is termed bone-glass, is superb. Another set is a delicate tint of green, with white enamelled decorations, in the style of old Venetian glass. A pair of glass vases, *à la renaissance* in design and decoration, is very beautiful. There is also an assortment of vases made of composite glass, imitating in design and decoration the old Etruscan glass. The engraving of some of the pieces is exquisite, being deeply cut and so perfect that not a line or distinct mark is visible. One fruit plate about 12 inches diameter, with deeply engraved ornamentation, is polished even on the engraved surfaces, the labor involving four months of time, and the price being $180.

Scientific American Supplement.

No. 25.

FOR THE WEEK ENDING JUNE 17, 1876.

PUBLISHED WEEKLY,

AT THE

OFFICE OF THE SCIENTIFIC AMERICAN,

No. 37 Park Row, New-York.

MUNN & CO., Editors and Proprietors.

O. D. MUNN. A. E. BEACH.

The SCIENTIFIC AMERICAN SUPPLEMENT is uniform in size with the *Scientific American*. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

COMBINED RATES.

The *Scientific American* and SCIENTIFIC AMERICAN SUPPLEMENT will be sent together for one year, postage free, to subscribers, on receipt of $7.00.

Remit by postal order. Address,

MUNN & CO., PUBLISHERS,

37 Park Row, New-York.

CENTENNIAL NOTES.

THE American Institute of Mining Engineers now holds a meeting weekly at 1121 Girard street, Philadelphia, and will continue to do so during the Exhibition. Among those present at one of the last meetings were Julian Deby, Delegate of the Belgian Government; Alfred R. C. Selwyn, F.R.S., Director of the Canada Geological Survey; I. Lowthian Bell, F.R.S., and Member of the British Parliament; Dr. Herman Wedding, Professor of Metallurgy and Commissioner of the Prussian Government; Christian Mosler, Mining Commissioner of the German Empire; L. Nicholsky and Nicholas Iossa, Imperial Russian Mining Engineers; James Hector, F.R.S., Director of the New-England Geological Survey; Henry Pettit, Engineer and Architect of the Centennial Commission, and A. L. Holly, President of the American Institute of Mining Engineers.

The meeting was called to order by Dr. R. W. Raymond, of the Centennial Committee of the Institute, who welcomed the visitors and introduced Dr. Herman Wedding, who gave an interesting account of mining and metallurgy in Prussia.

MEXICAN EXHIBITS.

Among these are coarse cotton and woollen cloths, silks of rather better quality, palm-leaf hats, saddles and bridles, curious woodenware painted in many colors with flowers and leaves, leather trousers, embroidered jackets, and pottery in imitation of ancient Aztec models.

A prominent object is a platter-shaped mass of silver smelted from 272 tons of argentiferous lead, and weighing 4000 pounds. Its value is $72,000, and it comes from the State of Michoacan. There is also a large and valuable exhibit of gold, silver, copper, and quicksilver ores, this feature forming the strong point of the collection. A beautiful stone called Mexican marble, translucent and resembling somewhat alabaster, but richly veined with rose and other tints, is profusely shown in the form of table-tops, paper weights, and mantel ornaments, we shall more fully describe this substance hereafter. Other noticeable exhibits are tobacco, cigars, candles, oilcloth, shoes, gloves, skins of wild animals, and a condensed form of the favorite Mexican strong drink, pulque.

PROCEEDINGS OF LONDON SOCIETIES.

MUSICAL ASSOCIATION.—APRIL.

MR. CHAPPELL in the chair. Lord Rayleigh, F.R.S., read a paper on "The Perception of the Direction of a Source of Sound." In the case of the eye it is well known how we locate the source of the excitation. The lens of the eye concentrates the light from external points on corresponding points in the retina; if the external point is moved, the point on the retina moves too. The possibility of this depends on the fact that the diameter of the lens of the eye is very many times larger than the wave-length of light. In the case of sound, the ordinary wave-lengths are, on the contrary, large compared with the dimensions of the head; and we could not carry about with us any apparatus that would focus sounds on points in a sensorium. Attempts at explanation of the power of localizing the direction of sound are generally based on differences of reception by the two ears. Experiments were made to determine the accuracy of the estimation. An observer with eyes closed was placed on the middle of a lawn; others walked about and spoke to him. The estimation of the direction was very exact, no matter whether the voices came from right, left, in front, or behind; even a single word or a single vowel was sufficient. When the voice was used in a non-natural manner, as in screaming or whistling, the estimation of right or left was unaffected, but uncertainty rose between the positions in front and behind. A tuning-fork on a resonance-box was employed; the noises of excitation interfered. Two forks were then provided and simultaneously excited; either was held over a resonator so as to produce a pure sound. The estimation of such sounds was good as to right and left, but failed entirely as to front and back. These results were unexpected. It was suggested that the estimation depends on our knowledge of the peculiarities in the quality of the human voice, and on variations of quality in the different positions. It has been supposed that the estimation as to right and left is based on the nearest ear to the sound hearing it most loudly. The following considerations throw doubt on this. One ear is stopped, a steady note sounded, and the observer turns round; the variation in strength is not a marked one. Also, theory indicates that the head is not a sufficiently large obstacle to make any considerable sound-shadow with ordinary wave-lengths, though it may do so for notes high in the scale. However, the sound of a tenor C fork, although very faint, was localized as to right and left without much difficulty. On the whole the matter appears to be obscure, and it was concluded that we are far from understanding the manner in which the estimation of the direction of sound is made. Dr. Stone observed that the semicircular canals of the ear have the reputation among physiologists of being the means by which we determine the direction of sound. Mr. Sedley Taylor inquired whether direction could be estimated with one ear only. Lord Rayleigh answered that it certainly could, much better than one would expect, and pointed out the difficulty of referring the phenomenon to the semicircular canals.

AIR COMPRESSION.

AT the Society of Engineers recently, Mr. V. Pendred, president, in the chair, a paper by Mr. J Steel on "Air Compression" was read. The author, in commencing, observed that although Hero, of Alexandria, had experimented on air compression, and had written a book on pneumatics, the subject did not assume practical importance until after the discovery of the ponderosity of the atmosphere by Galileo and Torricelli in the middle of the 17th century. Savery and Papin, two of the early inventors of the steam engine, appeared in modern times as first on record in connection with air compression. Savery used a double-acting bellows to give a constant stream of air for blast furnaces. Papin, whose ideas are particularly practicable, recommends the utilization of water-power to compress air, and force it to a distance for use. Papin may thus be said to have foreshadowed the now common practice of distributing air through mines to work machinery. In 1757 Isaac Wilkinson patented a method of compressing air by the use of a column of water. He effected his object by means of a series of vessels used one after the other, so as to keep up a regular pressure. This is an important proposition, and 100 years before its application indicates the method of procuring air employed by the engineers of the Mont Cenis Tunnel. In 1829 William Mann patented stage pumping; that is, a process by which, instead of raising the pressure at once, and in one pump, it is divided into several pumps, an increment of pressure being taken from each. That method, spread as it is over more time and surface, allows a considerable cooling of the air to take place, and a lowering of the initial heat of the air supplied to each pump, and so far reduces the waste of power in compression. It likewise reduces or distributes the mechanical strain, allows the use of lighter machinery, and reduces to a minimum the fly-wheel power required. The author then described Sturgeon's high-speed air compressor, and afterwards a small one designed by himself for compressing air for his patent railway brake. He showed that in an engine with one pump only of 30 inches in diameter, and working up to 500 pounds on the square inch, the pressure on the cylinder covers, and the lode on the cranks at the point of turning the centre would amount to 150 tons, while, if distributed over four pumps, that lode would be only 10 tons on each pump. That was the point to which the author attached most importance. He exhibited diagrams showing the effects of heat and expansion, and showed that even at the comparatively low amount of compression of two atmospheres, the heat doubled the volume, and if no means were taken to reduce the heat as it was formed a loss of half the power employed in pumping ensued. Formulæ for ascertaining the relations of compression and heat, and examples of the same, were also given. The author pointed out the necessity of placing air compression on a proper basis, as, whether an economical mode of using power or not, in mines, chemical works, diving bells, raising ships, and other operations, it had become a necessity. It was also to be regarded as an alternative from the cost and waste of horse-flesh to propel tramway cars.

EXPLOSIONS IN MINES.

A DISCUSSION on the means of preventing explosions in mines, took place at a recent meeting of the members of the French Academy of Sciences. M. Faye read a memorandum, in which he advocated the abolition of the Davy lamp, and the substitution of uncovered oil lamps placed about 10 yards apart in the mines. By this means, he said, the explosive gases would be consumed gradually as they escaped, and without accident, just as a ton of powder would be got rid of harmlessly if exploded in pinches. In the discussion which ensued it was demonstrated that this project would not answer, as the deleterious gases, when escaping, would remain inert until they bore an explosive proportion, about 8 per cent. to the atmosphere, in the same way as an ordinary gas jet, if turned on in a room containing a light, would not inflame, though an explosion would ensue when a sufficient quantity of the gas had mingled with the air. M. Faye was ultimately induced to withdraw his paper. The members present generally testified to the efficiency of the Davy lamps, if kept in good repair and used by careful miners; but, on the ground that these desiderata appeared to be unattainable, M. Boussingault gave his entire support to their abolition, and the substitution of electrical lighting apparatus, if a means of reducing the excessive cost of the latter could be devised. In the course of the discussion reference was made to the method established with respect to the Davy lamp by M. Boussingault in the petroleum mines in Alsace. Before the miners enter these mines, the efficiency of their lamps is tested by plunging them into a cylinder containing a petroleum vapor. The slightest flaw is detected.

STATE LAWS CONCERNING THE SALE OF PATENTS ARE UNCONSTITUTIONAL AND VOID.

FOR the convenience of correspondents who desire information upon this subject, we republish here some of the decisions of the United States Courts, together with remarks thereupon, as given in the *Scientific American*:

[From *Scientific American*, February 20th, 1875.]

ROGUS STATE LAWS CONCERNING PATENT RIGHTS.

WE have heretofore, on several occasions, called attention to the unconstitutionality of various State laws, by which local legislatures have attempted to regulate or prevent the sale of patent rights within their borders. In some of the States, laws have been passed by which patentees or their agents who offer patent rights for sale, without complying with certain State regulations, are made liable to fine and imprisonment.

We need hardly say that all such State laws are without binding force, and are in direct conflict with the laws of the United States; and any State judge or officer who should, under pretence of a State law, arrest or interfere with a patentee or his agent in the sale of a patent right, would be liable for damages and punishment in the Courts of the United States.

This question was adjudicated by the United States Court in the case of John Robinson, agent for the Goodyear Rubber Dental Plates patent, who, on offering to sell a right under the patent, was arrested and imprisoned under a State law of Indiana. The law in question made it unlawful to sell a patent right in that State unless the patentee or seller first deposited a copy of the patent with the county clerk, and made affidavit that the copy was genuine, had not been revoked, and that he was authorized to sell, etc. A certified copy of the affidavit was also given to the patentee or seller, and he was further required to exhibit the same to any person who might demand to see it.

The United States Court held that this kind of legislation is unauthorized, that property in inventions exists by virtue of the laws of Congress, and that no State has a right to interfere with its enjoyment, or annex conditions to the grant. If the patentee complies with the laws of Congress on the subject, he has a right to go into the open market anywhere within the United States and sell his property. If this were not so, a State might nullify the laws of Congress and destroy the powers conferred by the constitution

We believe there are some Western States that have not yet repealed their obnoxious patent laws; and for the convenience of district attorneys, lawyers, and patentees, we herewith give in full the decision of the United States Circuit Court, above alluded to.

INVALIDITY OF STATE LAWS REGULATING THE SALE OF PATENTS.

In the Circuit Court of the United States, District of Indiana. Ex-parte Major J. Robinson—Petition for writ of Habeas Corpus.

Be it remembered that heretofore—to wit, on the 30th day of May, 1870, before the Honorable David Davis, one of the Judges of said Court, the following proceedings in the above entitled cause were had, to wit:

It appears from the papers in this case that the petitioner, being the duly authorized agent of the owners of certain patents granted to Henry B. Goodyear, administrator, and to John A. Cummings, offered, on the 23d day of May, 1870, to Harrison H. La Fever, a dentist, in the county of Grant, in this State, the right to use the invention patented, for dental purposes, within said county, for the sum of $100, which the said La Fever agreed to pay. Before the sale was completed, the District Attorney of the county instituted proceedings against the petitioner under the provisions of an act of the legislature of Indiana, entitled "An Act to regulate the sale of patent rights, and to prevent fraud in connection therewith," which took effect on the 23d day of April, 1869.

These proceedings resulted in the petitioner being committed to the jail of the county, because he had failed, before he had offered to sell the patent right, to comply with the terms of the law.

If the law is valid, he was properly held in custody; otherwise, he should have been discharged. This law declares that it shall be unlawful for any person to sell or barter any patent right in any county within the State without first filing with the Clerk of the Court of such county copies of the letters-patent duly authenticated, and at the same time swearing to an affidavit before such clerk that such letters-patent are genuine, and have not been revoked or annulled, and that he has full authority to sell or barter the right so patented, which affidavit shall set forth his name, occupation, and residence, and, if an agent, the name, occupation, and residence of his principal. A copy of this affidavit shall be filed in the office of said clerk, who shall furnish a copy of the same to the applicant, who shall exhibit the same to any person on demand. Penalties are imposed for any violation of these provisions.

This is an attempt on the part of the legislature to direct the manner in which patent-rights shall be sold in the State, to prohibit their sale altogether, if these directions are not complied with, and to throw burthens on the owners of this species of property, which Congress has not seen fit to impose upon them. I have not time to elaborate the subject, nor even to cite the authorities bearing on the question, and shall therefore content myself with stating the conclusion which I have reached.

It is clear that this kind of legislation is unauthorized. To Congress is given by the Constitution the power "to promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries." This power has been exercised by Congress, who have directed the manner in which patents shall be obtained, how they shall be assigned and sold.

The property in inventions exist by virtue of the laws of Congress, and no State has a right to interfere with its enjoyment, or annex conditions to the grant. If the patentee complies with the laws of Congress on the subject, he has a right to go into the open market anywhere within the United States, and sell his property. If this were not so, it is easy to see that a State could impose terms, which would result in a prohibition of the sale of this species of property within its borders, and in this way nullify the laws of Congress which regulate its transfer, and destroy the power conferred upon Congress by the Constitution. The law in question attempts to punish by fine and imprisonment a patentee for doing with his property what the National Legislature has authorized him to do, and is therefore void.

The petitioner is discharged.

[From *Scientific American*, March 11th, 1876.]

PATENT RIGHTS *vs* STATE RIGHTS.

We have heretofore had occasion to call attention to the unconstitutionality of the various attempts, by State legislation, to interfere with the rights of inventors and patentees in the disposition of their patents. In some States, laws have been passed which practically authorize the citizens of such States to cheat the inventor out of his fees if he sells on credit. Such laws provide that a note given in purchase of a patent must state on its face that it is given for the patent, the number, date, and other particulars whereof must be designated on the note, otherwise such note shall be void, and the holder debarred from receiving payment. All such laws are, under the constitution of the United States, void. A note given for a patent right will be binding if drawn in the usual manner, all State laws to the contrary notwithstanding.

So in the case of that class of State laws that require the taking out of licenses in order to sell patents, or that require, under penalties, the filing of copies of patents with county or State officials as a condition precedent to selling patent rights within the boundary of any State—all such laws are unconstitutional and void. We have heretofore published the decisions of the United States courts declaring their nullity.

Another decision against the applicability of State laws to patent rights has lately been made by the United States Circuit Court, in Massachusetts, Anthony *vs.* Carroll, decided by Judge Shepley, October, 1875. This was an action to recover damages for an infringement which took place as far back as 1863, up to 1867. The defence was that under the State laws of Massachusetts—statute of limitations—the plaintiff could not recover, he not having brought the action within six years from the time of the alleged injury. This defence was not allowed. The court ruled as follows:

"Should the legislature of a State pass an act in express terms limiting the time for bringing an action in the federal courts for infringements of patent rights, there can be no reasonable doubt that such a statute would be unconstitutional

and void. The policy of the Government to provide a uniform system of rights and remedies throughout the United States upon the whole subject matter of patents for new and useful inventions and discoveries, by placing it under the control of Congress and the federal courts, would be frustrated if such State legislation could directly or indirectly limit, restrict, or take away the remedy."

RECOVERY OF INDIGO FROM SPENT VATS.

BY G. H. UNDERWOOD.

AFTER the lime and copperas vat used in dyeing calico has been as far exhausted as is practicable, there still remains a quantity of indigo, both in solution and with the insoluble residue, at the bottom of the vat which well repays the cost of recovering it. With regard to that which remains in solution, the usual custom is to allow the vat to settle well, and pump the clear liquor into an adjoining empty vat, and employ it in setting a new vat, instead of the same quantity of water. The insoluble matter at the bottom may be treated by three different methods.

(1.) It was proposed to treat the whole residue with an excess of muriatic acid, which would dissolve the lime, iron, and copper, and leave the indigo insoluble. This simple process does not, however, succeed in practice, a large quantity of acid is required to neutralize the lime, and it does not dissolve the sulphate of lime, sand, organic matters, lint, or fibre, which form a considerable portion of the bottoms, so that a small quantity of indigo is left diffused through a mass of foreign matters, in which it is so buried and hidden as to be nearly valueless.

(2.) The cold-water process is worked by having a number of pits or receptacles of large size at a lower level than the dyeing vats, and in communication with them. The vat bottoms are mixed with water, and well agitated. When the insoluble matters have subsided, the clear supernatant fluid is run into a large pit; the bottoms are again raked up with clear water, left to settle, and the clear run into the pit, and this treatment repeated as long as any indigo is dissolved from the bottoms. The weak indigo solution is soon oxidized in the pits and precipitates; by having a series of pits at different levels, and connected with one another, the last pit can be kept running off water free from indigo. The pits are drawn off at certain intervals, and the indigo collected. This process requires but little attention, and costs nothing in materials, but it will be shown that it is not successful in extracting the whole of the indigo from the residues.

(3.) The hot process consists in heating the vat bottoms with caustic soda and orpiment, and is the best process where there is not room or convenience for the construction of settling pits, and may perhaps be the best under any circumstances. The bottoms are placed in iron boiling vats, which are of such a size that one boiling vat is sufficiently large for the treatment of one dye vat, and there may be as many as necessary. The boiling vats are provided with plug holes at various distances from the bottom. A stock reducing liquor is made by taking in the proportion of 1 lb. orpiment, 1 gallon of strong caustic soda, and 4 a gallon of water; the orpiment is finely ground, and the whole boiled by steam in an iron vessel until solution is effected; it is usual to prepare about 30 gallons of the reducing liquor at one operation. From 3 to 4 quarts of this reducing liquor are added to the contents of the boiling vat, which are well raked up, and thoroughly boiled. The steam being turned off, the contents are allowed to settle, and drawn off by the plug holes into a cistern, and thence pumped up into spouts leading into receivers placed 10 or 12 feet above the dyehouse level. The spouts are purposely made broad and shallow, so as to cause the liquid to come as much as possible into contact with the air; the indigo in solution is speedily oxidized, becomes insoluble, and settles to the bottom of the receivers. The clear and hot liquor from which the indigo has been deposited, is used instead of water in the boiling up of a fresh lot of bottoms, or re-boiling a lot already treated. If the indigo vats have been well set, and well dipped out, it will be found that from five to seven times boiling with the orpiment liquor will be required to remove all the indigo from the bottoms, but there may be cases which demand twelve or fourteen successive boilings.

If the cold water process is the cheapest in materials, it imay be said in favor of the hot process that it is more rapid in action, and extracts more indigo from the bottoms. As to which of the two processes is really preferable on the score of economy, it can only be said that much depends upon circumstances of position, of quality of water, of methods of working, value of indigo, and space available. Experiments made under favorable conditions have shown that vat bottoms washed fourteen times with water and raked up in an exceptionably perfect manner at every washing ceased to yield indigo to water, white cloth not being in the least colored by prolonged immersion in the liquid. These vat bottoms, which were exhausted as far as the cold water could exhaust them, were transferred to the boiling vats and made up to 800 gallons with water and reducing liquor. When boiled in the usual way the first treatment showed that there was a sufficient amount of indigo dissolved to make it profitable to extract, and even up to the third boiling indigo was extracted in relatively large amounts from what would be considered in the old process an exhausted and valueless material. To ascertain quickly whether a given specimen of vat bottoms contains much or little indigo, the best process is to have the vat and bottoms vigorously raked up and a sample, say one quart, withdrawn; this is mixed with 250 grains of orpiment and a couple of ounces of caustic soda, and boiled in an iron pan, the liquid cooled, and then tested by immersing bits of white calico in the clear part. The depth of shade which is dyed in a given time will indicate sufficiently well to the experienced eye what is the probable amount of indigo present.—*The Textile Colorist.*

ICE SKATING IN SUMMER.

WE lately had an opportunity of witnessing skating on a real ice rink, which has just been opened to the public at the Old Clock-House, Chelsea, London.

Mr. John Gamgee, in a small plot of ground in the King's road, has opened what he calls a "Glaciarium"—an ice-formed rink—which has to some extent at least, shown that real ice rinks are not necessarily manufactured by King Frost, but can be provided by artificial means.

The rink building is 40 feet by 24 feet, and has an area of about 100 square yards. The ice surface is 37 feet by 24 feet, and forms a shallow basin about 3 inches deep, under which run series of copper pipes, of flat-oval section, 2½ inches wide by about ¾ inch deep. These pipes are connected at the ends so as to form continuous circulating U-shaped passages for the freezing solution which runs through them. The pipes are laid on 2-inch deal planks forming a level bottom or floor, these latter being first covered with tarred cow-hair—a kind of felt, ½ inch in thickness. Under the plank floor is another thick layer of cow-hair, 6 inches thick, this being laid on a 4-inch bed of loose dry earth, the latter in its turn reposing upon a bottom of concrete of about the same thickness. These media become a stratum of non-conducting value for the pipes, which are connected at one end of the rink with larger transverse pipes, one of which supplies the refrigerating liquid from the upper tank while the other returns it to the refrigerating apparatus. This circulation is kept up entirely by gravitation, the flow of the liquid through the pipes of the rink being caused by the head of liquid in the tank, and its return is effected by laying the return-pipes at a lower level.

But let us see by what agency the refrigerating power is produced. We see an air-pump, driven by a steam-engine, which keeps in circulation the cold-producing liquid (sulphurous acid), not ether, as formerly used. The refrigerator, inclosed in a wooden case, is constructed with a number of vertical tubes, and a similar-looking machine on the other side of the engine—also filled with horizontal double tubes of copper—acts as a condenser. The cold water flows through the inner tube, and outside the outer ones, the space between them being filled with the sulphurous acid, which is thus liquefied or condensed under pressure. By this process intense cold is produced, which is transmitted to a tank filled with the carrier or transmitter of the cold (nothing else than a mixture of glycerine and water of about equal parts), which circulates, by the tank-pressure already explained, through the rink, and then freezes the layer of water about 2½ inches deep. The intense cold of this circulating liquid—and we may here state that the solution remains uncongealed at a temperature below zero—produces a wonderfully perfect and uniformly hard sheet of ice, although it has to circulate from a tank placed some feet high, and traverse the U-shaped coils of the rink. After returning to the refrigerator, the temperature registered the other day 12° below freezing point. We are informed that the sulphurous acid results are just double those of ether as the cold-producing agent, and, with the exception of the sulphurous acid fumes formed in the engine-house, the whole process is one perfectly free from unpleasantness. We have, therefore, two simple chemical agencies—one a producer of cold, and the other the carrier; and it is to the solution of glycerine and water so happily made to answer the latter purpose that Mr. Gamgee's success must, perhaps, mainly be attributed. The dust or snow ground up in the skating is taken to a refrigerator, salt is added and the mixture is again used, so that no waste takes place. We are informed that an ice rink of a similar kind may be laid at a cost of £4 per square yard; and the working expenses are, we understand, not incommensurate with the results.—*The Building News.*

THE CASPIAN SEA.

GRIMM'S recent explorations in the Caspian establish the fact of volcanic activity in its southern and western parts. The phenomena are partly of a local and variable character, and also gradual and general, resulting in an upheaval of the coast, particularly noticeable on the west. From these causes rivers have changed their courses or entirely disappeared, and it is said that the Araxes, once a famous resort for fish, has now been almost deserted for the Persian rivers of Lenkoran and Sefid-rud. It is not improbable that volcanic agency may have diverted the Amu Daria, causing it to flow into the Aral instead of into the Balkhan and Michail gulfs. Animal life in the Caspian chiefly congregates near the western shores, where the water is deep (up to 108 fathoms) and food abundant, supporting vast quantities of fish and *crustacea;* while the eastern shore is shallow, covered with sand-drift, and appears to be a continuation of the desert lying beyond it. Grimm found many more animals than previous explorers (Eichwald and Bäer, Kovaleffsky and Peltsam) had discovered; he counted in all from 130 to 140 varieties, and of these the rarest specimens were obtained at a depth of between 30 and 108 fathoms. The Caspian Sea is, in fact, a huge lake of brackish water, whose upper strata are inhabited by fresh-water animals, while the great depths where the water is more salt and the temperature lower, are sought by the migratory, oceanic forms. But many of the purely Caspian types have so far changed their habits as to prefer the great depths and the salter water. Such are several species of the *Gammaridæ*, some of which, as, for instance, the *Mysis relicta*, have so changed in appearance as to count as new species; others, on the other hand, preserve their original form.—*The Academy.*

SOIREE OF THE ROYAL MICROSCOPICAL SOCIETY.

APRIL 21st Mr. H. C. Sorby, president of the Royal Microscopical Society, gave a large *soirée* in the appartments of King's College. Invitations had been issued for above 1500, including the whole of the Fellows of the Royal Microscopical Society, the presidents and leading officers of many of the London Scientific Societies; all the distinguished foreigners now in London as commissioners from the various foreign governments to the Exhibition of Scientific Apparatus at South Kensington; and many of the president's private friends. About 800 were present, including about 300 ladies. After having been received by the President and one of the secretaries, the visitors passed into the various rooms of the College, in which were exhibited many objects connected with microscopical science. For the number, variety, scientific value, or general interest of the specimens, this exhibition has probably never been surpassed. Amongst the new instruments may be mentioned Mr. Sorby's arrangement for accurately measuring the wave-length of the centre of absorption-bands in spectra; a new form of Stephenson's erecting binocular microscope, by Mr. Bevington, and another by Mr. Browning, of somewhat different construction. Mr. Browning also exhibited his new portable microscope, which is so constructed that the body can be turned on one side and reversed in such a manner as to reduce the height to about one half. The President also exhibited a large series of specimens illustrating his own special subjects, shown by means of fifty microscopes, lent to him by four of the principal makers in London (Becks, Browning, Crouch, and Ross), and about 150 first-rate instruments and objects were contributed by the Fellows of the society and other friends. These were so distributed over the large apartments of the College as to avoid crowding in any part. Almost every branch of science to which the microscope has been applied was well represented, and many of the finest specimens ever prepared were shown and described. Many very interesting living objects were sent direct from the Brighton Aquarium and elsewhere. In the lecture theatre were exhibited Dr. Hudson's most beautiful drawings of microscopic objects shown in a new manner as transparencies; Mr. Spottiswood's splendid polarising apparatus, and various objects shown with the oxy-hodrogen microscope by How and Company. The large entrance hall was decorated with plants and flowers, and used as a promenade. The two museums of the College were also thrown open. Refreshments were supplied by the steward of the College. The guests were supplied with a classified catalogue of the objects exhibited, but they were so numerous that it was impossible for any one to examine more than a small part of the whole. One of the most satisfactory results of the *soirée* is the great impression produced by it on the foreign scientific men, who appear to be quite unprepared for, and greatly surprised at, what they saw during the evening. —*Nature.*

IMMEDIATE CURE FOR COLD IN THE HEAD.

DR. D. FERRIER, in the *Lancet*, suggests a bismuth snuff for coryza. He says:—

I do not know whether the plan is absolutely original, but I am not aware of its having been adopted previously. This, however, is of no importance compared with the question of its efficacy.

On the evening in question, I began to suffer with the symptoms of cold in the head: irritation of the nostrils, sneezing, watering of the eyes, and commencing flow of the mucous secretion. Having some trisnitrate of bismuth at hand, I took repeated pinches of it in the form of snuff, inhaling it strongly, so as to carry it well into the interior of the nostrils. In a short time the tickling in the nostrils and sneezing ceased, and the next morning all traces of coryza had completely disappeared.

Bismuth, alone, therefore, proved quite successful, but it is better in combination with the ingredients in the following formula. Bismuth by itself is rather heavy, and not easily inhaled, and it is, moreover, necessary that it should form a coating on the mucous membrane. It is, therefore, advisable to combine it with pulv. acaciæ, which renders the bulk larger, and the powder more easily inhaled, while the secretion of the nostrils causes the formation of an adherent mucilaginous coating, of itself a great sedative of an irritated surface. The sedative effect is greatly strengthened by the addition of a small quantity of hydrochlorate of morphia, which speedily allays the feeling of irritation, and aids in putting a stop to the reflex secretion of tears.

The formula which I find on the whole the most suitable combination of the ingredients of the snuff is as follows:—Hydrochlorate of morphia, two grains; acacia powder, two drachms; trisnitrate of bismuth, six drachms. As this is neither an errhine nor a sternutatory, but rather the opposite, it may be termed an anti-errhine or anti-sternutatory powder. Of this powder one quarter to one half may be taken as snuff in the course of twenty-four hours. The inhalations ought to be commenced as soon as the symptoms of coryza begin to show themselves, and should be used frequently at first, so as to keep the interior of the nostrils constantly well coated. Each time the nostrils are cleared, another pinch should be taken. It may be taken in the ordinary manner from between the thumb and forefinger, but a much more efficacious and less wasteful method is to use a small gutter of paper, or a "snuff spoon," placing it just within the nostril and sniffing it up forcibly, so as to carry it well within. Some of the snuff usually finds its way into the pharynx, and acts as a good topical application there, should there be also pharyngeal catarrh. The powder causes scarcely any perceptible sensation. A slight smarting may occur if the mucous membrane is much irritated and inflamed, but it rapidly disappears. After a few sniffs of the powder, a perceptible amelioration of the symptoms ensues, and in course of a few hours, the powder being inhaled from time to time, all the symptoms may have entirely disappeared.

TO TAKE IMPRESSIONS OF LEAVES, ETC.

M. BERTOT, of the Paris Academy, has just made known a simple method of taking impressions of plants, requiring only a large sheet of paper, some olive (or other) oil, black-lead, ashes, and resin (or colophony). The paper is first lightly oiled on one side, then folded in four so that the oil may filter through the pores, and the plant may not come into direct contact with the liquid. The plant is placed between the leaves of the second folding, and in this position pressed (through other paper) all over with the hand, so as to make a small quantity of oil adhere to its surface. Then it is taken out and placed carefully on white paper; another sheet is placed above (since two impressions can be taken), and the plant is pressed as before. On now removing it an invisible image remains on the paper. You sprinkle over this a quantity of black-lead (or ashes, etc.), and distribute it in all directions, as in applying sand to writing; the image then appears in all its parts. With an assortment of colors, the natural colors of plants may be reproduced. To obtain fixity, resin is added to the black-lead (previously) in equal quantity; the impression is fixed when it is exposed to a heat sufficient to melt the resin.

HYPODERMIC USE OF MORPHIA.

THE *Medical Times and Gazette* quotes from Dr. Chouppe two cases in which very serious symptoms immediately followed the injection of minute quantities of morphia. This accident, he has found out, arises from the canula of the syringe having penetrated one of the minute veins, so that the morphia is thrown directly into the venous circulation. When this is the case, the patient, is twenty-five or thirty seconds after the injection of an ordinary dose, is seized with tinglings in the hands, which soon pervade the body, and are accompanied by very intense itching. The veins of the neck become swollen, the face is flushed, and the pulse beats violently, rising to 120, or even to 160. In about a minute and a half, a cold sweat pours off the surface; and in three or four minutes all urgency has ceased, although the heart may continue agitated for some hours after. In order to prevent the occurrence of these effects, the operation should be performed very slowly, so that injection may be at once stopped when tingling of the hands commences; or what Dr. Chouppe believes will prove the better practice will be to introduce the canula, not with the syringe already charged with the injection, but without the latter, and observe whether a vein has been penetrated, as shown by the issue of blood, drop by drop, from the canula. When this is the case, we should either puncture afresh in another place or push on the canula deeper, so as to traverse the wounded vein. After his precaution has been taken, the injection may then be made.

THE NEW NICOLAIEFF FLOATING AND DEPOSITING DOCK.

By Mr. LATIMER CLARK, C.E.

THIS dock, now being constructed for the Russian Government at Millwall, by Messrs. Clark, Standfield & Co., is designed for the purpose of raising the large circular ironclads which have recently created such great interest in naval circles, and also for docking the ordinary ironclads of the Russian Government. The popoffka Novgorod already constructed has, it will be remembered, a diameter of 100 feet, and another circular ironclad, the Admiral Popoff, has a diameter of 120 feet; and it has been stated that designs have been prepared for a third popoffka of 160 feet diameter, and there can be no doubt that even larger vessels than this will yet be designed. The largest dock entrances at present in existence do not exceed 82 feet, and it is believed that no entrance so wide as 100 feet has been hitherto proposed.

The depositing dock is quite unlike any other dock that has been proposed, inasmuch as it not only raises the vessels out of the water, but, when required, deposits them high and dry on fixed stages of open pile work, where they can be cleaned or repaired at leisure. It can also readily be altered in its form, so as to receive vessels of the ordinary type, or to dock circular ironclads of whatever size.

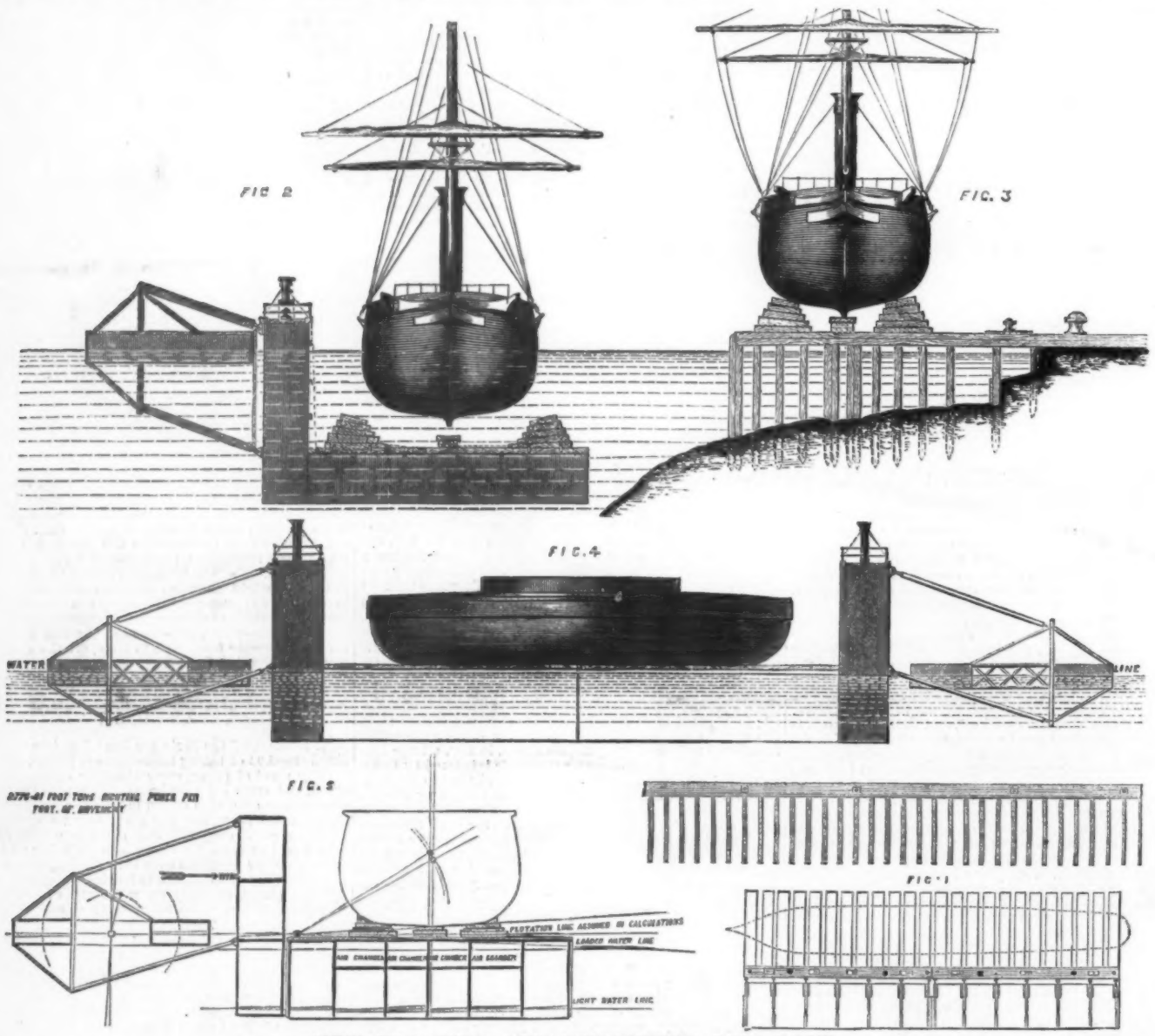
The depositing dock, in its general form, is composed of a number of pontoons, either of square or circular section, which lie parallel to each other at fixed distances apart, and which range transversely to the length of the dock; each of these pontoons is permanently connected at one end to a longitudinal structure which forms the main side of the dock; the pontoons project outward from the side of the dock in the same way as the fingers of the hand, so that the whole structure in plan resembles a comb. The pontoons, when the dock is lowered to receive a vessel, are submerged, but the side of the dock to which the pontoons are attached is never totally submerged, but is of sufficient depth to allow a freeboard of 6 feet or 7 feet when the pontoons are sunk beneath the bottom of the vessel. When the dock is raised, the tops of the pontoons are well above water, and the side of the dock stands up some feet higher than the deck of the vessel which it supports. Diagram 1 shows the plan of the dock; Diagram 2 shows an elevation of the dock submerged, ready to raise a vessel, with the outrigger attached. It will be seen that these elevations resemble the letter L. It is obvious that such a form as this —namely, a dock with only one side to it—would be perfectly unstable when submerged, but the necessary stability is imparted to it by means of the outrigger arrangement shown in Diagram 2. This outrigger consists of a broad, flat pontoon, divided into numerous compartments, and loaded with concrete ballast until it is half submerged. Its form gives it immense stability. It carries along its middle line a row of rigid upright columns, which project through the pontoon some distance above and below, and are stiffened by struts. To the top and bottom of each column is hinged a pair of parallel bars or booms, Diagram 3, which are also hinged at their opposite ends to the sides of the dock, as shown in the diagram, so that the outrigger remains stationary while the dock is free to be raised and lowered vertically, being always retained in a horizontal position by the action of the parallel bars or booms. The movement is, in fact, exactly that of a parallel ruler. Each of the pontoons is usually divided into about six separate compartments, by means of five transverse vertical bulkheads. The side of the dock to which the pontoons are attached is practically a long box-girder, divided by numerous bulkheads into large water-tight chambers. Its height may vary from 20 feet to 50 feet, or more; its width from 10 feet to 15 feet, and its length is about equal to that of the longest vessel intended to be docked. The pontoons are about twice the length of the beam of the vessel to be raised, so as to be available for paddle steamers. Their height may be from 10 feet to 20 feet, according to the weight of the vessel, and their width from 7 feet to 15 feet.

In the Nicolaieff Dock now in course of construction, the side is 280 feet long, 44 feet 6 inches high, and 12 feet broad. The pontoons are 72 feet long, 18 feet deep, and 15 feet broad, and the clear space between them is 5 feet. The machinery for working the dock is carried in the chambers of the side. It consists of a number of powerful pumps worked by steam-engines in the usual manner. When it is necessary to submerge the dock, the necessary valves are opened, and the water admitted through pipes to the compartments of the pontoons; the dock is thus gradually lowered, its horizontal position being at all times maintained by its connection with the outrigger. The vessel is then floated over the pontoons, water is pumped out until the keel takes its bearing on the blocks, the bilge-blocks are hauled into place by chains in the usual manner, and the vessel being firmly blocked and shored, the pumping is continued until the vessel is raised to its full height; the valves are then closed. In this position it will be seen that the dock with the ship on it has very great stability quite independently of that afforded by the outrigger; the outrigger having in fact performed its functions—namely, that of controlling the dock when submerged—is no longer of any service, and it might, should occasion demand, be entirely removed. It may be remarked that the dock in this condition is much narrower than any other form of dock, and it might with great facility be taken through any narrow entrance or channel; there is, however, no necessity to remove the outrigger for any other reason. While thus docked, the vessel can be examined, painted, and repaired as in any ordinary dock, or can be removed from place to place.

The great feature of this system is that this vessel can now be readily lowered on to a fixed staging along the shore, and there deposited high and dry as shown in Diagram 3, leaving the dock free to raise or lower another vessel, or any number of other vessels. This staging consists of a series of piles driven into the ground in rows parallel to each other, these rows standing at right angles to the shore, as shown in Diagrams 1 and 3. The rows of piles are capped by horizontal timbers, which are exactly the same distance apart from centre to centre as the spaces between the pontoons are, so that if the width of the pontoons is 10 feet, the clear space between the piles is 12 feet, leaving 2 feet for clearance. The height of the vessel above the water is greater than the height of the staging, so that when the dock with the vessel on it is brought alongside the staging the pontoons can enter freely between the rows of piles, and the vessel is carried directly over the staging without touching it. The dock is now slightly lowered by admitting water into the pontoons until the vessel rests upon the keel-blocks on the fixed staging; bilge-blocks are now placed under the bilges, and the vessel being securely shored, the dock is lowered just clear of the vessel, and drawn out from the staging, and is then of course ready to receive other vessels. The lifting the vessel off the stages and lowering it into the water is simply the reverse of this process.

Reverting now to the general form of dock, it may be well to observe that it is designed in two halves, each of which is capable of readily docking the other for purposes of cleaning, painting, etc., or of being used as a smaller but complete dock. In Diagram 1 these two halves are shown connected ready to receive a vessel of ordinary form. Diagram 4 represents them connected for docking a circular ironclad. One of the more important advantages is the great facility with which the power of the dock may be increased as often as the growing trade of the port may render necessary. This is accomplished by simply adding a third section in the centre of the dock, which may be done without necessitating the alteration of the existing portion, and at an expense not exceeding that which would have been incurred in the first instance. In common with other floating docks, this form has the advantage of requiring no fixed foundations, of being easily removed from place to place, of being capable of transporting vessels over shallows, and of possessing great economy of working and first cost. It is of course vastly quicker in operation than an ordinary graving dock, inasmuch as in the latter case the whole space of the dock has to be pumped dry, while in the depositing dock only a weight of water equal to that of the vessel has to be raised, and that through a smaller height. In fact, the Nicolaieff Dock is capable of raising a vessel of 4000 tons in little more than an hour. One advantage this form of dock possesses to a greater extent than any other, is the thorough exposure of the vessel to sun and wind, which is of considerable importance both in painting and repairs.

One obvious use of this form of dock is to transport railway trains across ferries from one side of a river or lake to the other. The complete railway-train is run on to a cradle resting on the piles, and being perfectly secured therein is lifted away by a dock of this form provided with false bows, and fitted with propellors, and is then deposited on similar staging on the opposite shore. The advantages claimed by this dock have been thus summed up: (1) With one dock any number of vessels can be docked and deposited high and dry out of water on wooden platforms, in a convenient position for cleaning and repairs, along the waste sloping shores of a river or dock. (2) The provision of an additional length of staging at

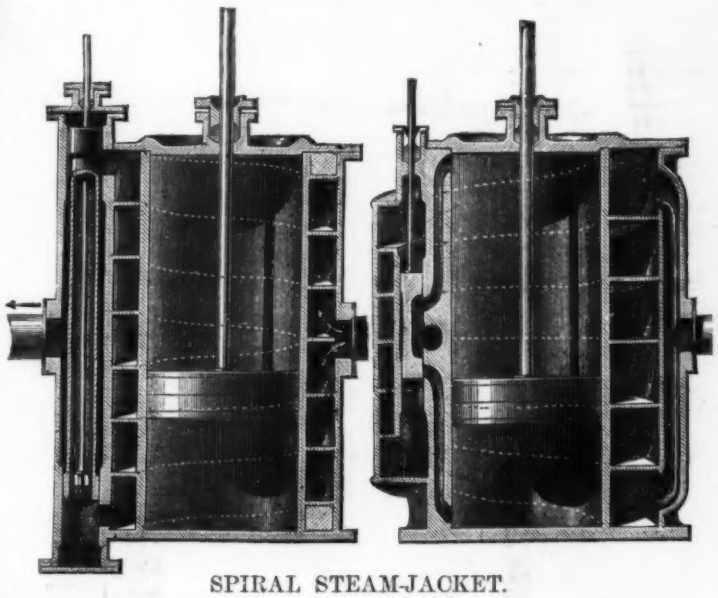


NEW FLOATING AND DEPOSITING DRY DOCK.

a comparatively nominal cost is equivalent to the building of an additional dock. (3) As the dock is used ordinarily for lifting vessels on to the stage, it can be kept at all times ready to receive disabled or other vessels, which can be at once deposited on a stage and the dock left free for further use, and in this respect has a great advantage over all other descriptions of graving docks. (4) A vessel can be placed upon the staging, cut in two, and readily lengthened by lifting one half further along the staging by means of the dock. (5) Vessels can be conveniently built on these stages on an even keel and launched without the slightest strain, and without the risk and cost of launching, and without occupying the space required for the formation of ordinary ship ways. (6) Vessels, when on the dock or stages, are thoroughly exposed to the action of the sun and wind, allowing the paint to dry and harden rapidly, and affording great facility for examination and repairs. (7) The dock, with or without a vessel, may be readily transported from place to place, for the purpose of raising or depositing vessels at different points. (8) The dock will not, under any circumstances, sink, even if all its valves be intentionally left open. (9) One half of the dock can be readily raised level upon the other half for the purpose of cleaning or repairs. (10) By the use of air, which may be stored in some of the cylinders under compression, a vessel may be raised, sighted, and lowered again in less than an hour. (11) These docks, if constructed in the first instance too small for the requirements of trade, can be at any time enlarged to any extent at the same rate per ton as the original cost. (12) The docks are capable of receiving vessels of any size or length, or of a width too great to pass through ordinary dock-gates; such, for example, as circular ironclads of 100 feet or 150 feet diameter. (13) Lastly, in point of price, this dock is without any rival.—*The Engineer.*

A SPIRAL STEAM-JACKET.

IT is a defect of the usual form of steam-jacket, a mere envelope about the cylinder, that the steam passes directly from pipe to valve, thus heating only that portion of the cylinder about which it passes, while the ends of the annular space may be filled with stagnant steam which has greatly fallen in temperature. To obviate this difficulty, it is proposed in the *Bulletin du Société de l'Encouragement* to place spiral partitions in the annular space, so that the steam is compelled to traverse its entire extent. Our engravings illustrate this arrangement for two types of engines. In that using the valve shown in Fig. 1, the steam-pipe enters at the middle of the cylinder, and there the current of steam is compelled to traverse two spirals, one ascending and the other descending.



SPIRAL STEAM-JACKET.

In the second system, Fig. 2, the place of entry of the steam is the same; but, instead of at once passing to the spirals, it is led by suitable conduits to the ends of the cylinder, and there enters two inversely inclined spirals, and then passes to the valve which intersects both helicoidal chambers.

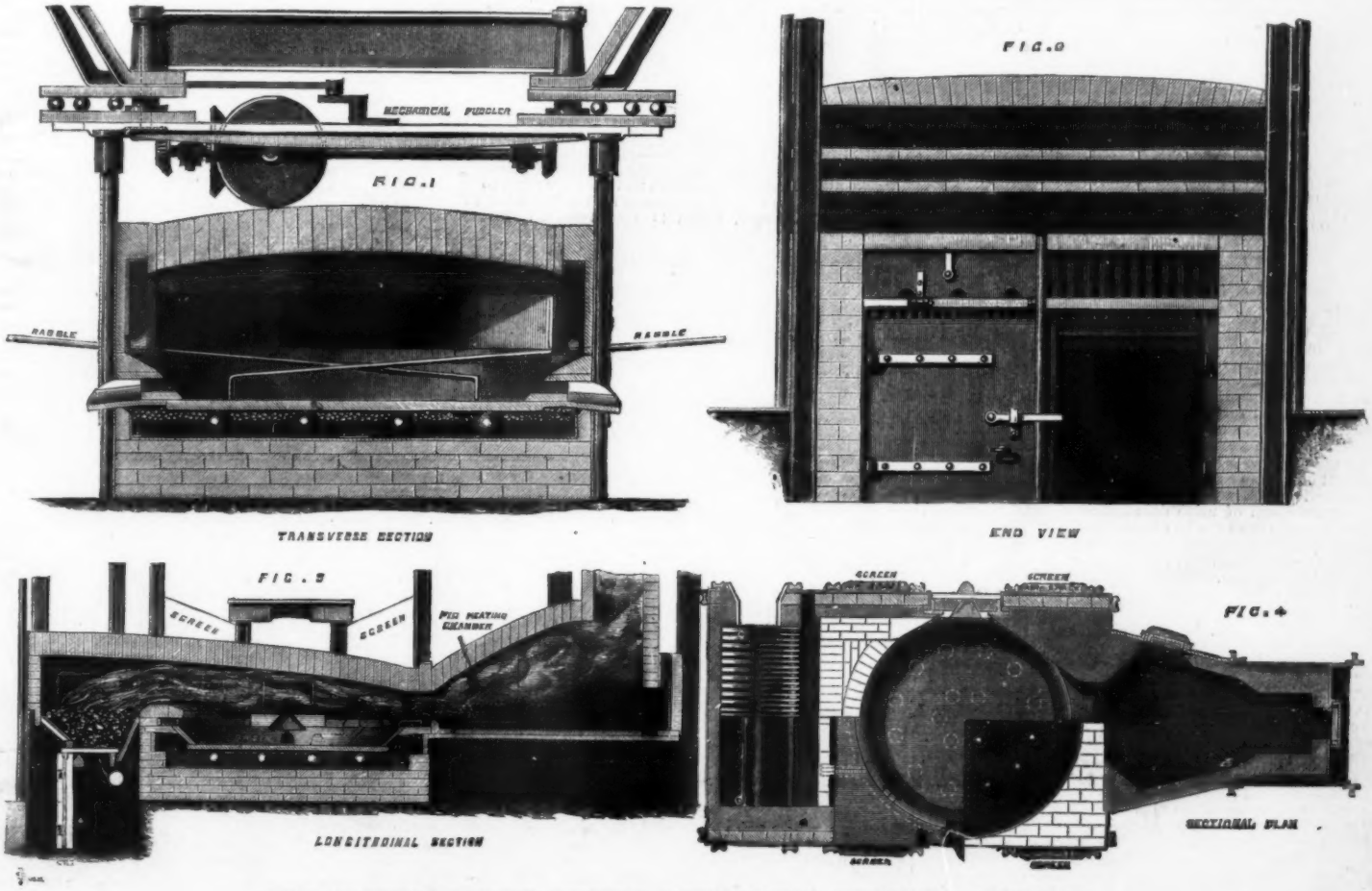
The circulation of steam will be quite rapid through the jacket, owing to the high piston speed commonly employed. In a cylinder 29½ inches in diameter, the total length of five spirals would be 442.6 inches, and the steam would pass over this space once per second, the piston making one stroke in the same interval of time.

THE CASSON-DORMOY MECHANICAL PUDDLING FURNACE.

AT the late meeting of the Iron and Steel Institute the paper on this furnace, read by the manager of the Earl of Dudley's estate, elicited what was held to be a most animated and interesting discussion. The continued high price of coal and low selling price of iron gave an importance to the subject that might not have been gained a few years ago. At the Round Oak Iron Works of the Earl himself this system of furnace has been tried between three and four years, and three such furnaces have for a long time been producing 90 tons of iron weekly, consuming about 16 cwt. of screened slack per ton, against 30 cwt. per ton by the old method, saving about two-thirds in fettling, and from 1*s.* to 1*s.* 6*d.* per ton in bricks and castings. It is stated that the quality of the iron is found to be superior to that made in the ordinary furnace. Three similar furnaces at the Tudhoe Iron Works, Spennymoor, have produced even better results, the output being greater, and the average consumption of coal per ton for the year being only 12 cwt. The Wigan Forge and Rolling Mills Company are laying down the whole of their new worked by steam. This combination was first contrived by Mr. Casson, to whom is also due the present peculiar grate of the furnace, as also the revival and full development of the "dandy" or pig-heating chamber.

The furnace shown in the engraving, is double. Fig. 1 is a cross section, Fig. 2 an end view, and Fig. 3 a longitudinal section. The plan, Fig. 4, shows the whole furnace with the dome removed, so as to lay bare the grate, the puddling bed, and the preparatory chamber. The grate is fitted with a cast-iron plate of the full width of the furnace, and sloping upwards to the bridge at an angle of about 30°. The back of the grate also slopes to an angle of 30°, and is constructed of cast-iron fire-bars set close together. The bottom is also formed of ordinary round or square bars. Blast is admitted about 5 in. below the bars on each side, the bottom being kept air-tight, as also the sloping back; this back has a drop door to enable the under hand occasionally to prick the bars. The area of the grate is only 5 ft. 10 in. by 1 ft. 10 in., being somewhat less than that of an ordinary single furnace. The main object of the sloping plate is to prevent any clinkers forming at the back, as the blast of air keeps it cool. The grate is fed in the usual way. The puddling basin rests on a brick pillar about 1 ft. 4 in. from the ground. On this is first set a wrought-iron circular open dish with sides about 4 in. deep; within this dish eight or more friction balls 5 in. in diameter are placed at equal distances from each other. On these spheres two cast-iron semicircular plates are laid. On these plates, again, four side or segment plates are bolted together externally by means of wrought-iron pins, and forming a complete circle. Upon these are placed loosely the shelf or table plates, which, resting upon brackets fixed to the rail buckstaves, support the walls of the furnace. All the plates forming the basin are thus free to expand and contract with the variations in the temperature. The dish below being kept full of water, the evaporation produced from the heat above cools the bottom and sides, and consequently the fettling. As soon as the iron is melted, the rabbles in the preparatory chamber are fixed to the machine, and worked at the slow motion for about five minutes. The speed is quickened until the iron boils, when the slower speed is put on till the iron drops. The heating chamber is then charged; this is done with a few pigs at a time, so as to enable the iron to get equally heated all through. The rabbles are then removed, and the real work of the puddler begins by his balling up the iron in the usual manner. The balls, which are of the ordinary size, are drawn from each door and the cinder tapped. A few shovelfuls of hammer slag and scale are thrown on the bed, and the pigs, which have meanwhile been supplied into the preparatory chamber, are again passed over. These generally melt on the bed in ten minutes or a quarter of an hour. The charges of about 10 cwt. usually take from an hour and twenty to an hour and forty minutes. Iron shields are fixed on each side of the doors between the two buckstaves and about 1 ft. from the ground floor. It is found that the heat of the upper portion of the furnace induces a circulation of cold air between the casings thus formed and the surface of the brick walls, and protects the puddler when the door is drawn up to pull out the balls.

Mr. Scattergood, the manager of the Stour Valley Works of the Patent Nut and Bolt Company, gave, in an interesting speech, the favorable results of his tests of two furnace trials conducted in a remarkably cautious manner. He point-



THE CASSON-DORMOY DOUBLE MECHANICAL PUDDLING FURNACE.

ed to the complete control over the fire given by the use of the blast on a small grate area, resulting in a saving of fuel of 40 per cent.; to the sloping sides and simple system of cooling of the puddling basin, as accounting for the saving in fettling; to the combination with the dandy as accelerating the work; and to the use of the rabbling apparatus as greatly diminishing the puddler's labor. To the use of such machinery, with the complete and regular stirring up the metal thereby attained, Mr. Lowthian Bell ascribed the improvement in quality of the produce.—*The Engineer.*

[Nature.]

THE PHYSICAL CONSTITUTION OF STEAM.

I BELIEVE the following remarks on the physical constitution of steam are in some degree original, in form at least, though perhaps not in substance.

Dr. Andrews has shown by his experimental researches on carbonic acid, that at a temperature above 31° C. or 88° F. the difference between the gaseous and the liquid states no longer exists. I quote the following brief statement from an admirable paper on the subject, by Prof. James Thomson, in the "Proceedings of the Belfast Natural History and Philosophical Society," 1872; he is speaking of the case in which a given quantity of carbonic acid, of which part is in the gaseous and part in the liquid state, is kept at constant volume, while the temperature, and consequently the pressure, are gradually increased:—

"As the temperature and pressure are augmented, the gaseous part is always increasing in density, and the liquid part is diminishing in density, till at last the two come to have the same density with one another, and then they are perfectly alike in every respect, all distinction between them vanished. At this stage the temperature is 31° C., and the pressure is about seventy-five atmospheres. Above this temperature of 31° no change of pressure can cause gasification or liquefaction; and above this pressure of about seventy-five atmospheres, no change of temperature can cause gasification or liquefaction.

This temperature of 31° C. is called by Dr. Andrews the critical temperature for carbonic acid. Above its critical temperature, although carbonic acid may have the density either of a gas or of a liquid, the two states are not sharply separated from each other as a liquid is from its vapor, but graduated into each other insensibly. It is believed that every gas and vapor has its own critical temperature. Those of the permanent gases are believed to be so low as to be unattainable by any known process. That of water or steam, on the contrary, is probably too high to be observed in a glass tube, and consequently too high to be directly observed at all: for the only known test of the critical temperature being attained, consists in the disappearance of the visible boundary surface between the liquid and the vapor or gas. My purpose is to show how the critical temperature for steam may be approximately estimated with a great degree of probability.

The fact that the latent heat of steam diminishes as the temperature increases, formerly seemed to me one of the strangest of all facts; but the above-mentioned properties of carbonic acid, and no doubt of all gases and vapors, make it quite intelligible.

The *latent heat* is defined as the heat given out when steam is condensed into water of its own temperature. The *total heat* is defined as the heat given out when steam is condensed into water at zero Centigrade, and is the sum of the latent heat and the temperature. According to Regnault, the relation between temperature and total heat is expressed by the formula—

$$\lambda = 606.5 + .305\,t.$$

λ being the total heat and t the temperature. This has been ascertained to be true from 0° to 230°, and if it is true for all temperatures, at a temperature of 872.7 the total heat and the temperature would be the same, and the latent heat would vanish: 872.7 is consequently the critical temperature which is deducible from the above formula for water.

JOSEPH JOHN MURPHY.

THE FERMENT OF UREA.

M. MUSCULUS has described a new test-paper, by means of which urea in solution can be recognized even when present in very small quantity. He obtained it by filtering ammoniacal urine, washing the filtrate with distilled water, and coloring it with turmeric. This paper contains a small quantity of the ferment in its pores, where it may be preserved for a very long time. When the paper is dipped in a solution of urea, and then exposed to the air, it becomes brown in a few minutes. This change of color is due to the action of the ferment, which metamorphoses the urea, a neutral body, into carbonate of ammonia, without action on the turmeric paper.

Every specimen of urine does not furnish this ferment; some specimens can even be exposed to the air for months in summer without undergoing alkaline fermentation. The thick glutinous ammoniacal urine passed by patients suffering from catarrh of the bladder, is the richest in this ferment. Such urine cannot be filtered, because the mucus in a short time forms an impermeable coating, which stops up all the pores of the paper. If strong alcohol be added to it, however, the mucus coagulates into a mass resembling fibrine, which can be easily isolated from the fluid. This mucus is itself the ferment. In order to preserve it, it must be dried by a gentle heat, pulverized, and placed in a tightly corked bottle. This urea ferment possesses none of the properties that characterize the organized ferments, but has, on the contrary, a great resemblance to the soluble ferments, such as the diastase, the saliva, and the pancreatic juice; in fact, according to M. Bouchardat, acids and alkalies hinder the action of the diastase, while alcohol, ether, and creosote exert no influence over it. The same is true of the urea ferment. Carbolic acid is the only acid that exerts no action on this ferment.—*Bulletin général de Thérapeutique.*

DETECTING ARSENIC IN PAPER-HANGINGS.

M. KUPFFERSCHLAEGER.

SCHWEINFURT-GREEN, known also as mitis-green and mountain-green, is a compound of the arsenite and acetate of copper too frequently used, in spite both of advice and of legal prohibition, for coloring paper-hangings, ball-dresses, artificial flowers, wafers, bon-bons, and toys. Every winter we hear of needle-women experiencing serious affections after having made up costumes of tarletan colored or printed with Schweinfurt-green; that dancers wearing similar materials, and with wreaths of artificial flowers in their hair, experience violent headache on the morning after the ball; that similar symptoms have been experienced by persons who have slept for some nights in rooms papered or painted with green; and, lastly, that children have been seized with vomiting after having eaten bon-bons or sucked toys coloured green. The author's method of detection is as follows:—The stained paper, divided into strips is placed in a porcelain soup-plate, and covered with a solution of chlorate of potash saturated when hot, and the whole is heated in the water-bath, till the paper is completely dry. Then it is set on fire, and instantly covered with a large glass-bell so that nothing may be lost. The ash is pulverized, and immediately exhausted in the cold with the water which has served to rinse out the bell and the plate after the combustion. Thus all the arsenic combined with the potash is dissolved, and not the oxides of chrome, copper, aluminium, and of tin and lead if present. This colorless solution, filtered, and mixed with sulphuric acid till a slight acid reaction is distinguished, is then introduced into a Marsh's apparatus which has been submitted to a blank test, and found free from arsenic.—*Revue Universelle.*

TO MAKE WATER-PROOF PAPER BAGS.

By ALBERT S. DENNISON, Carthage, N. Y.

FOLD a strip of paper in such manner that its longer edges shall overlap, and then paste or cement together the edges, thus forming a long flattened paper tube, which is subsequently cut up into proper lengths. The bag or flattened tube is passed through felted rollers, one of which runs in a vat containing a solution of waterproofing material, which I prefer should consist of one to two parts of tallow to one hundred parts of rosin dissolved in naphtha. From between these waterproofing rollers the formed bag passes to other felted rollers, between which it is pressed so as to remove surplus moisture. The bag or that side of the bag requiring to be sealed is subsequently closed in any suitable way—as, for instance, by folding this side or end on to itself and binding it.

[Microscopical Journal.]

NEW COLORING AGENTS IN THE EXAMINATION OF THE TISSUES.

IN a memoir devoted to the subject of amyloid degeneration of the kidney, liver, and spleen, which appears in a recent part of the "Archives de Physiologie," M. Cornil, of La Charité, gives the results of his experiments with several new coloring matters. Two of these, according to the *Lancet*, were methyl-anilin violets discovered by M. Lauth, the third was a violet discovered by M. Hoffmann, of Berlin. The preparations can be stained with these violets either when fresh or after being hardened in spirit (Müller's fluid or picric acid); and the coloring agents have this peculiarity, that certain tissues, as cartilage, decompose them into a violet-red and a blue-violet, each of which becomes fixed in different elements of the tissue; the hyaline matrix, for example, assuming a red color, whilst the nuclei and cellules, as well as the cartilaginous capsules, become of a blue-violet tint. The normal tissues of the liver, kidney, and spleen, however, do not decompose the violets, but when amyloid degeneration is present, the degenerated and semi-transparent parts resembling colloid become of a violet-red, whilst the normal elements are tinted of a violet-blue, and thus a means equal, if not superior, to that of iodine, is afforded by which the changes may be followed.

RECOVERING VARNISHES FROM OLD LOOM-HARNESS.

By LEANDER BUTLER, Rockport, Mass.

TAKE two hundred pounds of old loom-harness, and put into a kettle, and water to cover, add forty pounds sal-soda or other suitable alkali. Subject to heat, and boil for three to five hours, or until the varnish composition is separated from the twine of the harness, which is then removed from the solution.

The alkaline solution of varnish, usually of copal, linseed-oil, and turpentine, is next subjected to the action of sulphuric or other acid, sufficient in amount to neutralize the alkali—say fifteen pounds of vitriol. The gummy and oleaginous constituents of the varnish will now generally rise and float on the liquid. This floating residuum is to be now removed and subjected to a strong heat, or is to be put in pans in an oven and baked, the heat employed being about that used in baking bread, and the baking being carried on for about thirty minutes. The baked matter is next to be suffered to cool, after which it will be ready for use for various purposes in the arts, it being especially valuable in the manufacture of dressing for leather.

PREPARATION OF HALF-WOOLLEN GARMENTS FOR DYEING.

IN many dye-houses garments before dyeing are washed with soap and afterwards rinsed. Although this procedure cannot be called bad, it is not to be absolutely recommended. Imperfect rinsing often involves spots and inequalities in dyeing. Where soft water is scarce, other materials are substituted for soap. Of these the most suitable is soda, a strong lye of which removes most spots. To cleanse 20 garments for subsequent dyeing, a tub large enough for the goods is filled with hot water, at about 130° F., and in it 4 lbs. 6 ozs. of soda crystals are dissolved. The goods are laid as loosely as possible in the water, and steeped for four to five hours. One garment after the other is then taken out and laid upon a clean table. A very strong and hot solution of soda is prepared in a smaller cask, a brush is dipped in the liquid, and with it the dirty spots are rubbed till they disappear. To remove hardened grease spots, such as are produced by stearine, paraffin, tar, &c., benzine must be employed. A rubber is moistened with this liquid, and applied to the spots till they are removed. The rubber used here in place of a brush consists of a soft woollen rag rolled tightly up, and sewed up in a piece of cotton or linen. When the garment has thus been thoroughly cleansed it is rinsed.—*Farber-zeitung.*

FIXATION OF EOSINE.—Dissolve in water, thicken with gum, add arsenite of alumina; print, the goods having been previously prepared with stannate of soda, steam and wash. Or, mix with a solution of eosine its equivalent of the acetate of lead, of tin, or of alumina, previously thickened, print on linen which has been prepared with stannate, or with oil, steam and wash. Or, which is the best method, add to the eosine three times its weight of tannin, thicken, and print on pieces previously prepared with gelatine, steam and wash. Eosine does not combine with ordinary mordants; it attaches itself to albumen, but the shades are flat.—*Bulletin de la Société Industrielle de Rouen.*

SOLUTION OF COAGULATED ALBUMEN.

IT is well known that albumen, if kept too long, or heated above 95° F., becomes partially insoluble, and useless for printing. J. Wagner treats such samples at blood-heat with pieces of calves' stomach, taking to 14 ozs. of albumen 1 oz. of calves' stomach, previously washed in cold water, and cut in square pieces. This is stirred up in 1¾ pint of water acidulated with ¾ oz. of muriatic acid. After 36 hours the clear liquid is strained off, and neutralized with ammonia. The solution is then fit for use. G. Witz effects a similar artificial digestion with sheeps' stomachs, steeping for 40 hours in a lightly soured liquid at 104° F. Colors fixed with albumen can be discharged by means of pepsine, which acts equally well upon the albumen of blood and of eggs. In a very analogous manner irregular finishings can be removed by treatment with malt, which converts the starch into sugar.—*Reimann's Farber-zeitung.*

AMERICAN FLAX MANUFACTURE.

AN example of how to start new industries of porcelain, beet sugar, linen manufacture and a great variety of others of less importance, is just given us in an account of the starting of a linen manufactory at Manchester, N. H. The land suited to flax was properly tilled and the flaxseed sown, two bushels of seed to the acre, with no further attention until the first blossoms began to close and turn brown, when the flax was pulled and dried, then threshed of what seed had ripened, then thinly spread and rotted by alternate moisture and drying until the fibre was easily removed, then broken thoroughly and swingled, hatchled and tied ready for spinning. All this has since been done by machinery. A skilled flax-spinner from Scotland was now employed with a carder and a few spindles and a loom, and the work commenced slowly and carefully, and the work made to proceed as those interested became perfect masters of all the business. The result is that a linen manufactory has been put into operation, the practicability of the manufacture demonstrated, and those interested are prepared to enter the business with no risk of disaster.

COMPARATIVE VALUE AND STRENGTH OF ASTRINGENTS.

	Strength.	Price per Ton. £ s. d.	Cost per Unit. s. d.
Catechu	85	22 1 8	5 2
Extract of Hemlock	61	21 6 8	7 0
Gambier	55	26 0 0	9 5
Divi-divi	50	18 4 8	7 3
Valonia	35	19 15 10	11 3
Extract of Chestnut	31.5	17 3 4	10 10
Myrobalans	30	16 13 0	11 1
Mimosa	27	9 7 3	6 11
Sumac	18	21 6 8	23 8
Oak-bark	10.5	6 13 4	12 10

—*British Trade Journal.*

These figures must of course be taken as approximations merely. The market fluctuates continually, as one or other of the articles is more or less abundant, or incidentally more or less in demand. Different samples of divi-divi, sumac, myrobalans, &c., vary also in strength. Still the comparative efficiency of these wares may be roughly learned from this table. Sumac, it will be seen, if we compare strength and price, is more than twice as costly as any other ware of the class. The mere proportion of tannin, however, is far from being the only circumstance which the dyer has to take into account, and hence sumac maintains its ground, whilst the extracts of hemlock and chestnut and mimosa are little employed, and oak-bark not at all.

FIXATION OF WHITE INDIGO, BY STEAMING ON COTTON GOODS.—M. Schultz, of Rouen, patents the following process: he mixes 6 lbs. 9 ozs. of indigo, ground up in water with 19 lbs. 11 ozs. of copperas, dissolved in 105 pints of water to 26½ lbs. of slaked lime. Stir for an hour, let settle and precipitate by taking for 96 pints of the clear liquid 23¼ ozs. weight of muriatic acid, and the same weight of tin crystals. Filter. The color for printing is made by thickening the precipitate thus obtained with gum senegal, and adding a little ammonia.

MANUFACTURE OF ALUM UNDER PRESSURE.—In reply to a question whether the temperature of a mixture of sulphuric acid and clay will not be raised by the direct introduction of steam, Dr. M. Faudel says: "I hold the direct introduction of steam into a mixture of sulphuric acid and clay improper, because condensed water is thus obtained, and the weakened sulphuric acid cannot act so effectively upon the clay. All that is necessary is to envelop the closed leaden vessel in a cover, into which the required quantity of steam is blown. The closed leaden vessel can also be heated to a certain degree in a paraffin bath; the effect will be the same."—*Papier Zeitung.*

METHOD OF RECOVERING INDIGO, COCHINEAL, MADDER, AND OTHER COLORING MATTERS FROM WOOL OR WOOLLEN FABRICS.—By Sanceau and Melleville.—Wool or woollen fabrics containing indigo cochineal, madder, or other coloring matters, are placed in a digester of great strength, and exposed to the action of steam at a high pressure, until all the coloring matters contained are entirely dissolved. A weight of 1000 kilogrammes, say a ton, is exposed for six hours under a pressure of 40 to 50 kilogrammes per 3 centimetres square (75 to 94 lbs. per square metre). When the solution is complete water is added, and the whole boiled for some minutes to render the mass more liquid, passed through a coarse filter to retain foreign matters, and through a second filter to retain the indigo, cochineal, madder, or other dyes. These colors are washed with water, filtered again, and dried. The solution which has run through the filters can be used in the manufacture of prussiate of potash, sulphate of ammonia, or of manure.—*Moniteur Industriel Belge.*

DIRECT PREPARATION OF CAUSTIC SODA BY STEAM.—The decomposition of common salt by superheated steam in presence of silica and ferric oxide is the method referred to. The presence of the latter substances has been found to introduce difficulties, and it is proposed to dispense with them. The apparatus for the purpose is figured and described. It consists essentially of a bent tube, through which superheated steam is passed to carry off the hydrochloric acid formed. The tube leaked during the experiment, so that the yield could not be determined. Puddling the salt in an atmosphere of superheated steam on a hearth was unsuccessful, hydrogen instead of hydrochloric acid having been copiously evolved, the yield being only 4 to 6 per cent. of caustic soda. With better arrangements, it is hoped that a higher yield will be obtained.—*Le Technologiste.*

PHYLLOCYANIN AS A REAGENT.

GUIDO PELLAGRI.

PHYLLOCYANIN, the blue coloring matter of flowers, is a reagent which may render some service in chemistry on account of its exquisite sensibility to the least traces of alkali. It is best preserved along with such a slight trace of acid as may give it a dull purple color. Phyllocyanin will prove a valuable substitute for litmus in volumetrical operations, as there can be no doubt as to the end of the reaction. The following table shows its sensitiveness as compared with litmus:—

Potash.	Phyllocyanin.	Litmus.
1/100	Transient green, then yellow.	Distinct reaction.
1/1000	Green rather stable, and then yellow.	" "
1/10000	Stable Green.	" "
1/100000	" "	" "
1/1000000	" "	Reaction scarcely manifest.
1/2000000	At first green, then stable blue.	" "
1/3000000	Stable blue.	No reaction.
1/4000000	" "	" "

Phyllocyanin is most readily obtained from the iris and the blue violet.—*Gazzetta Chimica Italiana.*

CHANGE IN THE COLOR OF THE HAIR.

DR. WALLENBERG, of Dantzic, reports the case of a young man of twenty-one who had an attack of scarlet fever followed by an unusual desquamation, in which over almost the whole surface of the body the epidermis was raised by exudation from the rete Malpighi, having this exposed in places as large as the palm of the hand, and in places covered with mucous crusts. Some small abscesses also formed. Subsequently he lost completely all the hair from every portion of his body; and where it grew again, instead of being dark brown as before, it was white, as in an Albino. The tint of his skin, too, changed from brownish to milk white, with a reddish tinge. The microscope also showed its condition to be completely analogous to that of the Albino. The cause of this loss of color, which has now lasted seven years, Dr. W. attributes to the destruction of the pigment-cells of the skin and hair-cells by the profound inflammatory action. The skin has also remained extremely irritable as shown by the occurrence of several outbreaks of general eczema after comparatively slight irritations.

DYEING RECIPES.

From Reimann.

BROWN ON STRAW. (11 lbs.)

I.—Boil for two hours with 4 lbs. 6 ozs. fustic, 3¼ lbs. orchil, 1¼ ozs. argol, and the same weight of logwood.

II.—Boil for an hour in the solution of 3¼ lbs. catechu, drain and work in a fresh beck made up of 2 lbs. 3 ozs. copperas, and rinse.

LEMON YELLOW ON WOOL. (218 lbs.)

Boil up 83 lbs. fustic, 13 lbs. 2 ozs. alum, the same weight of tartar, 1¼ lbs. tin crystals. Skim the beck, enter, and boil the wool for 1½ hour.

PORCELAIN WHITE ON WOOL. (218 lbs.)

Clear the water with 2 lbs. 3 ozs. perchloride of tin at the heat of 100° F., add 1¼ ozs. neutral extract of indigo, and 2¾ oz. cudbear, and work the wool for half an hour.

CALICO PRINTING.—BLACK ON COTTON YARNS.

Dissolve in water 5 lbs. 7 ozs. of solid French extract of logwood, and 17½ ozs. of gum tragacanth; make up the solution to 21 pints, in which dissolve 4½ ozs. extract of bark. Let cool and stir into the mixture 2 lbs. 3 ozs. black liquor at 20° B., and 17 ozs. nitrate of iron at 50° B. Print, hang up for two days, steam, and wash.

If a very blue tone is required, the nitrate of iron is left out.

BLACK ON MERINO. (16 lbs. 6 ozs.)

Make up a beck with 3½ ozs. chromate of potash, 1¾ ozs. blue vitriol, 8¾ ozs. argol, and 6½ ozs. sulphuric acid. Boil up, cool down, and enter the goods, previously washed and rinsed. Boil for three-quarters of an hour, lift, take through water, and dye at a boil for three-quarters of an hour in a fresh beck made up with 22 lbs. St. Domingo logwood, with the addition of 6½ ozs. sulphuric acid. If a bluish shade is desired, cool and add 17½ ozs. ammonia. Rinse and dry.

To finish, take the pieces through 17½ ozs. gum tragacanth, dissolved in 70 quarts of water.

FAST LILAC ON WOOL.

Take 11 lbs. peachwood, 5¼ lbs. logwood, 22 lbs. alum, 11 lbs. argol. Enter, boil for an hour, and then add 2 lbs. 3 ozs. bichloride of tin, and boil for a quarter of an hour longer. To brighten the color the solution of 3½ ozs. of methyl violet may be added.

ROSE ON WOOL TO BEAR MILLING. (110 lbs.)

Boil up 13 lbs. 2 ozs. alum, 5 lbs. 7 ozs. tartar, 8¾ ozs. perchloride of tin, the same weight of tin crystals, and 2 lbs. 3 ozs. of cochineal. Cool, enter the wool, and boil for an hour.

LIGHT BLUE FOR LINEN (72 yards 29 inches wide).

Boil the goods for an hour with 2 lbs. 3 ozs. soda-ash, rinse, and give a light blue in the cold vat. Sour with 3½ lbs. sulphuric acid and rinse. For the finishing, prepare a mixture of 108 pints with 2 lbs. 3 ozs. wheat starch, and the clear solution of ¾ oz. of Gentiana violet B., and 8¾ ozs. of alum, pass through this at 122° F., and calender.

If the color is not required to be quite fast, give a rather paler shade in the vat, and prepare the following finishing:—Boil out 11 lbs. St. Domingo logwood in water, and dissolve in the clear decoction 17½ ozs. alum. Boil up in the liquor 3½ lbs. starch, let cool, and stir in it 17½ ozs. sulphate of zinc, and ¾ oz. tin crystals. With this make up 105 pints, work in it for half an hour, dry and calender. The goods must pass evenly through the mixture, as folds and creases make the color uneven.

BLACK ON STRAW HATS.

The hats are first steeped in a beck of soda at 5° Baumé at the heat of 122° F., for three hours, rinsed, and soaked over night in a sumac beck, containing 2¼ lbs. sumac per 5 hats. In the morning take out and drain and soak for three hours in a cold beck of black liquor at 2° B. Take out, drain, and lay the hats separately to air for six hours; rinse and dye at 144° F., with 2½ lbs. logwood per 11 lbs. of hats till the shade is reached. Lift, drain, dip singly in a lukewarm beck containing 8¾ ozs. glue per 17 pints of water; dry and rub with a hard brush.

THE DANGERS OF CHLOROFORM.

PATRICK CONNERS, an inmate of the city hospital, died at that institution recently while under the influence of chloroform. The circumstances of his death give peculiar interest to his case, and make it one likely to attract the attention of the medical world to a more thorough examination of the degree of danger involved in the use of chloroform as an anæsthetic.

Conners was an Irishman of about thirty. He had been in the hospital for some days, seeking surgical treatment for the index-finger of the right hand, which had been severely crushed by an accident. He was a stout, hearty man, of much more than average vitality and strength, and not at all likely, from outward appearances, to succumb to any operation recognized by experienced surgery.

In medical technology there are four different periods through which a patient under the influence of chloroform passes. The first is called the period of excitement; the second, the period of intoxication; the third, the period of rigidity; and the fourth, the period of complete effect. Conners was very violent at first. After a few inhalations he began to shout loudly about engines and cars and wheels and tracks—calling to some imaginary person to get out of the way, and to some other imaginary person to "back fast," and so on. He was re-enacting the scenes of his daily life, which had been that of a railroad employee. He soon became quiet, however, and his pulse and breath were closely watched by the attending physicians.

Just then it occurred to Dr. Lankford that by changing the position of the table upon which Conners lay, the requisite operation could be performed to much better advantage. A moment later, and a position exactly suited to Dr. Lankford had been obtained. Meantime the chloroform had been withdrawn from Conners, and a period almost long enough for the patient to have recovered from its influence had elapsed. Dr. Lemmen was about to renew the administration of the anæsthetic, when Dr. Lankford noticed heavy stertorous breathing, under manifestly great effort on the part of his patient. The chloroform was again withdrawn and Dr. Lankford, becoming alarmed, called for his forceps, with which he quickly seized Conners's tongue and pulled it forward, at the same time pulling his jaws apart so as to give him all possible opportunity for breath. Finding no benefit from this, the head was lowered, and all known appliances for artificial respiration were resorted to, such as moving the arms up and down, rubbing the body in different parts, but all to no purpose. The patient sank rapidly. Electricity was then brought into requisition. The batteries were applied according to the direction of the best medical authorities, but after an hour's work it was apparent that further effort was useless. Conners was dead beyond all hope of resuscitation.

The remarkable feature of this case is that at no time had Conners been thoroughly anæsthetized. The chloroform had been administered to him slowly and with great care, and he had just entered upon the period of rigidity when its administration was entirely discontinued. His limbs were just becoming rigid when the change of the position of the table, above referred to, caused what was intended to be only a temporary discontinuance of the drug, and it was not used again. The attending physicians were men of long experience and of high standing.—*St. Louis Democrat.*

SALICYLIC ACID IN THE TREATMENT OF ACUTE ARTICULAR RHEUMATISM.

SALICYLIC ACID, since its introduction into the materia medica, has been very extensively employed as an antiseptic and febrifuge. Its exact value in both of these offices is still apparently *sub judice*. Within a few months, surprising results have been claimed for it in the treatment of acute articular rheumatism, and we give below a summary of the results attained by several recent German observers. Thus Dr. Stricker, from its use in Prof. Traube's wards, declares that it has been found on trial to be a remedy capable of definitely curing recent cases of rheumatic affection of the joints in an exceedingly short time. He does not claim for it the power of absorbing exudations which have already taken place in the joints; in the acute stage he finds improvement is coincident with the fall of the temperature. He considers it harmless, if given in doses of from 7 to 15 grains an hour. While these are safe doses for young and vigorous persons, they may, in those who are advanced or weakly, produce some excitement, with ringing in the ears, deafness and sweating. To prevent relapses, he advises that the acid should be continued in diminishing doses for some days after the chief symptoms are subdued. The acid is of very doubtful utility in chronic rheumatism, and that associated with gonorrhea and dysentery. Dr. S. uses the pure acid in a pulverized or finely crystallized form.

Dr. Hildebrandt, in the *Deutsche Med. Wochenschr.* No. 7, 1876, gives the details of a case of acute rheumatism, occurring in a girl of eleven, to whom he gave the salicylic acid in doses of 3¾ grains hourly, with the result of complete relief of the symptoms at the end of thirty-six hours. It was continued in doses of 1½ grains for some days longer.

At the end of a short article on the various uses of salicylic acid, in which its use in diphtheria occupies most attention, Dr. Robert Buch, from his own experience in a number of cases, confirms the favorable views of Stricker regarding its use in acute rheumatism. With him, too, it has proved unsatisfactory in the chronic form. He prefers to give it, as recommended by Hanow, in solution with phosphate of soda; and not, according to the plan of Schulz, suspended in mucilage.

L. Riess, of Berlin, is inclined to speak more guardedly than Stricker of the action of the acid in rheumatism. Thus he recommends it as a valuable antiseptic in this disease, and says that in many cases, especially when coming early under treatment, a great amelioration of the symptoms is coincident with the defloresence. From his figures, however, it would appear that the duration of treatment in a majority of cases is not very short. His own plan was to give the remedy in large single doses, combined with soda, as often as the temperature reached 102.2° F., but he afterwards adopted Stricker's so far as to give 15-grain doses hourly; using as before, however, the solution with phosphate of soda, and not the pure crystals. Still his results were much less favorable than Stricker's. He has more recently used the commercial salicylate of soda.

Dr. Julius Steinitz, of Breslau, gives details of three cases, in which he gave to two adults doses of 7½ grains hourly of the pure acid, and to a child of six and a half years 3 grains at the like intervals. The two former were practically free from pain and fever after nineteen and twenty doses respectively, although the second one had been complicated with very violent delirium. The child required but sixteen doses. Dr. Steinitz, too, has found it entirely valueless in chronic rheumatism.—*Berl. Klin. Woch.—Allg. Med. Cent.-Zeit.*

REMOVAL OF DENTAL NERVE FOR NEURALGIA.

By Prof. JAMES E. GARRETSON, M.D., D.D.S.

MISS S——, about 21 years of age, a young lady of much personal beauty, had suffered severely for over three months with neuralgic pains, shifting from branch to branch of the fifth nerve. During this period the most powerful opiates had not secured her an hour's sleep in any one night; even two grains of morphia or twenty grains of croton chloral had no effect whatever. Dr. Garretson, finding treatment to be of no avail, decided to operate, which was done Wednesday, February 9th, 1876, at the residence of the patient, in the presence of Prof. D. Hayes Agnew, M.D., who administered the anæsthetic, using ether and a small quantity of chloroform. When the patient was in complete narcosis, Dr. Garretson made an incision of about two inches and a half in length at the base of the left inferior maxilla; raising and pushing the facial artery from the facial notch, he cut anteriorly across a branch of the artery, which was ligated; then, dissecting down to the periosteum, removed (with trephine, small chisel, and saw) the roof of the inferior dental canal, fully exposing it from the anterior mental nearly to the posterior dental foramen, making an opening of about two and a half inches in length and one quarter of an inch in width. The exposed part of the inferior dental nerve, which was found to be very much softened and disintegrated, was then removed; a portion that had not been uncovered by the operation was incised, and gotten away by means of a cutting probe at its entrance at the ramus of the jaw. Alum-water was injected into the canal, washing it out thoroughly. A piece of linen was inserted into the cavity as a plug, and the opening closed by means of ligatures. There was but a very limited hemorrhage during the operation.

Dr. Garretson, who has performed operations upon this nerve a number of times, maintains that when neuralgia arises from a lesion of it, the present fashion of removing a limited portion, as practised by the use of the ordinary trephine, affords relief only in exceptional cases, and that for the reason that the portion diseased is seldom removed through such manner of exposing it; an assertion which was fully corroborated in the condition of the nerve as found in the case reported.—*Dental Cosmos.*

THE CARBOLIC ACID SPRAY.

IN a paper in the *Archiv für Klin. Chirurg.*, by Prof. Von Nüssbaum, of Munich, the writer gives some details of much practical interest with regard to the preventive and curative treatment of hospital gangrene. In 1872, the first year of its appearance in the hospital, the gangrenous condition of the wounds in those attacked was always readily and successfully controlled by the local application of lotions containing nitrate of silver, corrosive sublimate, or carbolic acid; but as the distinctive changes became more and more acute, it was found necessary to have recourse to more active means, and to apply caustic pastes and the actual cautery. Energetic applications of the latter agent proved the most efficacious, and a perfectly successful result of such treatment was usually indicated by a previous fall of the patient's temperature. During the prevalence of the gangrene many different attempts were made to protect healthy wounds and sores from contagion. The continuous water-bath and applications of ice, moist warmth, and lotions of carbolic acid, salicylic acid, chlorine water, etc., were tried, but without any good results. At last Lister's antiseptic plan of dressing was practised most strictly, so that no open surface was dressed save under the carbolic-acid spray, and no instruments or dressings used save after careful disinfection. The hospital gangrene at once ceased, and not a single case, Prof. Von Nüssbaum states, has been observed in his ward since the adoption of this plan of dressing, although at the period of its first use eighty per cent of the surgical patients had been affected. Prof. Von Nüssbaum asserts that he feels it his duty to testify to the efficacy of Lister's method as a prophylactic against hospital gangrene. He insists, however, upon the necessity of carrying out this plan of dressing in all its details. He holds that the secret of its great success in this instance lay in a pedantic exactness in its mode of application, and he expresses it as his opinion that the surgeon who allows a wound to remain for one second open to the air, and unprotected by the carbolic-acid spray, cannot reasonably expect any good results from his practice of Lister's method.

SELF-DEVELOPMENT OF OVA.

DR. MOQUIN-TANDON, of Paris, gives some remarkable observations made on the unimpregnated eggs of frogs, showing a limited power of self-development. The process was more rapid than in fecundated eggs which were allowed to develop at the same temperature. Only a small number of the ova presented this evidence of commencing development; the majority died without sign of segmentation. In all cases the phenomena soon ceased, the spherules produced soon separated, and the whole mass began to decompose. Sometimes death occurred after the division into two or four segments, sometimes at a more advanced period, but the ovule never assumed the mulberry look. M. Moquin-Tandon points out that the observation establishes incontestably that the ova of vertebrata not impregnated by spermatozoa may pass through the earliest stage of development in certain conditions, the exact nature of which is at present unknown. These facts may be placed beside those of the same kind observed by Bischoff on the sow, by Hensen on the rabbit, by Agassiz and Burnette on fish, and especially with the remarkable fact observed by Oellacher that in fowls kept far from a cock, unfecundated eggs undergo segmentation in the interior of the oviduct.—*Medical and Surgical Reporter.*

PRESENCE OF BILE COLORS.

FOR the clinical demonstration of the presence of bile-pigment in urine, Dr. Rosenbach, Jena (*Centralblatt Med. Wiss.*, No. 1, 1876), recommends the following methods as an improvement on those ordinarily employed:—The urine is filtered through ordinary white filter-paper, by which means the latter is rendered of an intense yellow or brown tint. If a drop of slightly fuming concentrated nitric acid is now allowed to fall on the inner side of this prepared paper—that is to say, on the side which was turned toward the fluid—the spot which it touches becomes yellow, then yellowish-red, and at the edge of a beautiful violet tint; further out there forms an intensely blue ring, which passes over almost immediately into an emerald green color. It is best to use the paper in the moist state, without allowing it to dry after filtration. The play of colors produced by the acid is beautifully shown by allowing a drop to trickle down the inner surface of the filter, the reaction becoming more intense the nearer the acid gets to the apex of the cone. If the filter be allowed to dry and is put aside for a few days, it is only necessary to moisten it with distilled water, and then to use a drop of acid, to obtain a characteristic play of colors.

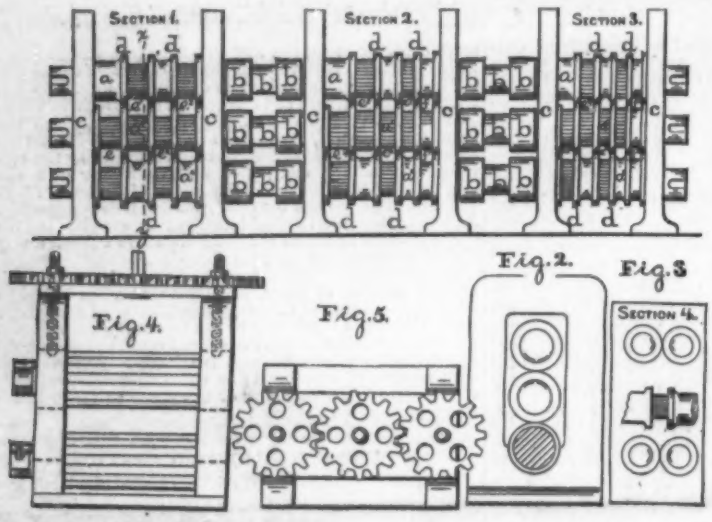
REDUCING STEEL AND OTHER INGOTS.

By GEORGE W. BILLINGS, Cleveland, O.

FIGURE 1, front elevation of three-high rolls, with their housings, couplings, and spindles. Fig. 2, vertical section of the same on the line $x\,y$ of Fig. 1. Fig. 3, part cross-section and part front elevation, arrangement of the rolls. Figs. 4 and 5, elevation and plan of the rolls.

In Fig. 1 the rolls are marked $a\ a^1\ a^2$, the couplings and spindles b, and the housings c.

The rolls $a\ a^1\ a^2$ are divided, respectively, by collars d, into several cogged and plain spaces, as shown. The opposing cogged spaces in the several rolls correspond in diameter, and they, with the collars, form boxes or ways, $e\ e^1\ e^2\ e^3\ e^4\ e^5\ e^6\ e^7\ e^8\ e^9\ e^{10}$, for the passage of the steel ingots or piles of steel bars, as shown in Fig. 1.



The portion of each of the rolls $a\ a^1\ a^2$ comprised in sections 1 and 2 are twenty eight inches in diameter (measuring through the collars d), and the portion of each of them comprised in section 3 is twenty-six inches in diameter.

The size of the box e is eleven by twelve inches; box e^1, ten by twelve inches; box e^2, eleven by ten inches; box e^3, ten by ten inches; box e^4, nine by ten inches; box e^5, eight by ten inches; box e^6, eight by nine inches; box e^7, eight by eight inches; box e^8, seven by eight inches; box e^9, six by eight inches; box e^{10}, six by seven inches.

The box e (eleven by twelve inches) is arranged for an ingot twelve by twelve inches in the cross-section, so that at each passage of the ingot through this box it shall be reduced one inch in thickness. When the ingot has been passed through the rolls twice—that is to say, through the box e and then through the box e^1—it is reduced to ten by twelve inches. It is then turned on edge, and the third passage—to wit, through the box e^2—reduces it to ten by eleven inches; the fourth passage—to wit, through the box e^3—to ten by ten inches; and so on through the boxes of diminishing size until it has been reduced to the desired size.

The boxes f and f^1 (each eight by eight inches) and the boxes f^2 and f^3 (each six by six inches) are smooth, the opposing rolls being, for these spaces, without cogs. These smooth spaces are provided for smoothing the ingots, and for removing the corrugations formed on the surfaces of the ingots during their passage through the cogged spaces $e\ e^1$, etc.

The cogs are constructed in regular gear form. For rolls of the size represented in Fig. 1, the cogs should measure two inches from centre to centre and one inch in depth, the face or width of each cog being about fifty-three one-hundredths of their two-inch pitch, thus giving to the face of each cog more than one-half of the space between the cogs.

I prefer to run the rolls at the rate of twenty inches per second, but this speed may be varied as required.

The action of the cogs is to force the metal from the top and bottom to the middle of the ingot or pile, and, the pressure being great, causes the silicon to flow into the cracks, seams, and porous places (the surplus silicon to escape through the pores and at the ends of the ingot as it passes through the machine), and when the ingot or pile leaves the machine it is thoroughly worked, and is solid and freed of foreign matters.

The rolls above described are adapted to the working of ingots and piles of all the usual sizes; but the rolls and boxes may be varied in size, observing the proportions stated.

For ingots or piles less than six inches square in the cross-section, rolls of eighteen or twenty inches diameter are large enough, and cogs arranged from one-quarter to one and three-quarter inch pitch will answer the purpose.

For compressing and reducing plates and sheets, I make use of the two-high rolls represented in Figs. 4 and 5. These rolls are cogged from end to end, or fluted, no dividing-collars being employed, and the top of the roll is adjusted by screws at each end, as in ordinary plate-mills.

The cogged rolls herein referred to are essentially different from, and are not to be confused with, the corrugated rolls commonly used in rolling steel ingots. When my cogged rolls are employed the bearing of the cogs on the metal is only at intervals; but when the corrugated rolls are used, the bearing of the rolls is continuous, owing to the shallowness of the flutes or furrows.

Power is applied to the rolls in the ordinary manner. The power required to compress ingots by the above-described process is only one-fifth of the amount of power required to effect the same results by the ordinary draft process.

A twelve-inch-square ingot, when drawn by ordinary plain or uncogged rollers, is drawn asunder the entire square of one hundred and forty-four inches, whereas, by my above described process, only twelve inches of the metal are acted upon by the cogs at one and the same instant.

The capacity for work of the machine represented in Fig. 1 is ten tons per hour.

For piles composed of bars of steel, I employ rolls arranged as shown in Fig. 3—namely, two pairs of horizontal rolls and one pair of upright rolls, these several rolls being cogged and otherwise constructed as shown in Fig. 1. A pile of the description last referred to I pass once through these rolls, when it is in condition to be drawn by the ordinary draft process.

I use the described process and machinery for brass and copper ingots as well as for steel ingots.

The process consists substantially in passing steel ingots and piles through the boxes or cogged spaces of the rolls to disengage the silicon and force it into the seams and porous parts of the ingot or pile, and to express the surplus silicon through the pores and out at the ends of the ingot, and then smoothing the corrugations on the compressed ingot or pile by passing the same through the smooth boxes of the rolls.

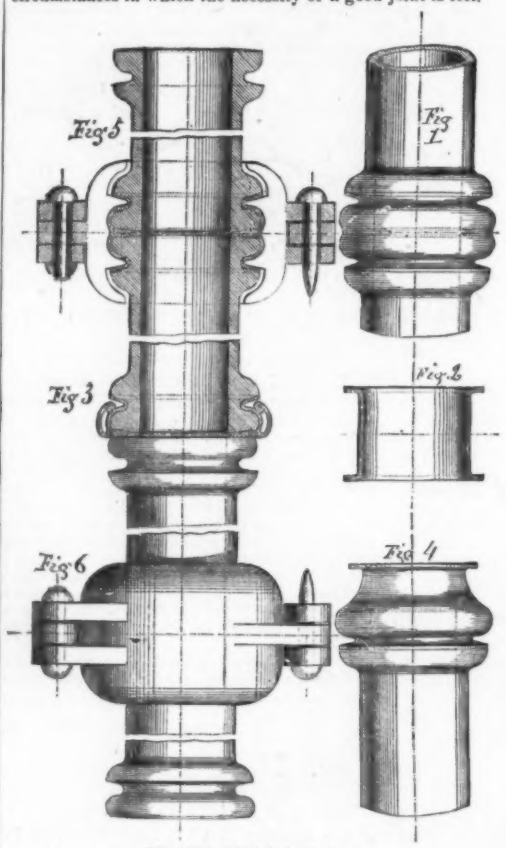
THREE-CYLINDER STEAM ENGINE.

WE give, below, an engraving of a large three-cylinder steam engine, made on Mr. P. Brotherhood's well-known plan by the Hydraulic Engineering Company, Limited, of Chester, for the Cyclops Iron Company, Limited, of Openshaw, Manchester, to drive their rolling-mills. The three-cylinder engine is particularly well adapted for this purpose from its compactness, and also from the fact that it gives great regularity in running, from the position of the cylinders at angles of 120° with each other, and there being no dead centres. The engine we illustrate is the largest of its type which has yet been made. It has cylinders 24 in. diameter with 18 in. stroke, the pistons all working on to one crank. The cylinders are bolted to the main framing, and the main bearing is supported upon three wedges, which can be tightened up by means of bolts to take up any wear in the brasses. The valve, which is driven direct from the crank and serves all three cylinders, is contained in one of the side pedestals. The governor acts upon a throttle valve within the steam valve. The exhaust is beneath the engine. The 13-ton fly-wheel is mounted on the engine-shaft, which is coupled direct to the rolling mill without the intervention of gearing. The speed is varied from 80 to 140 revolutions per minute, according to the size of the bar being rolled, and the engine is working very satisfactorily. The illustration is self-explanatory as to the general arrangement. —*Engineering.*

ELASTIC PIPE-JOINTING.

THE inconveniences which attend the use of pipe-joints fitted with flanges or made tight with lead or red-lead have induced M. Roche, of Wassy, to contrive a system of india-rubber jointing illustrated below. The use of flange jointing, which converts a set of pipes into a single rigid cylinder, is attended with various accidents arising from inequalities of the layer of earth on which the pipes rest, and the contraction and expansion to which they are subject from variations of temperature. Lead, if it preserves the joint, does so at the expense of the pipe; but in the usual way the fillet of lead gives with the shrinking or expansion of the pipe, or under any strain which tends to bend it.

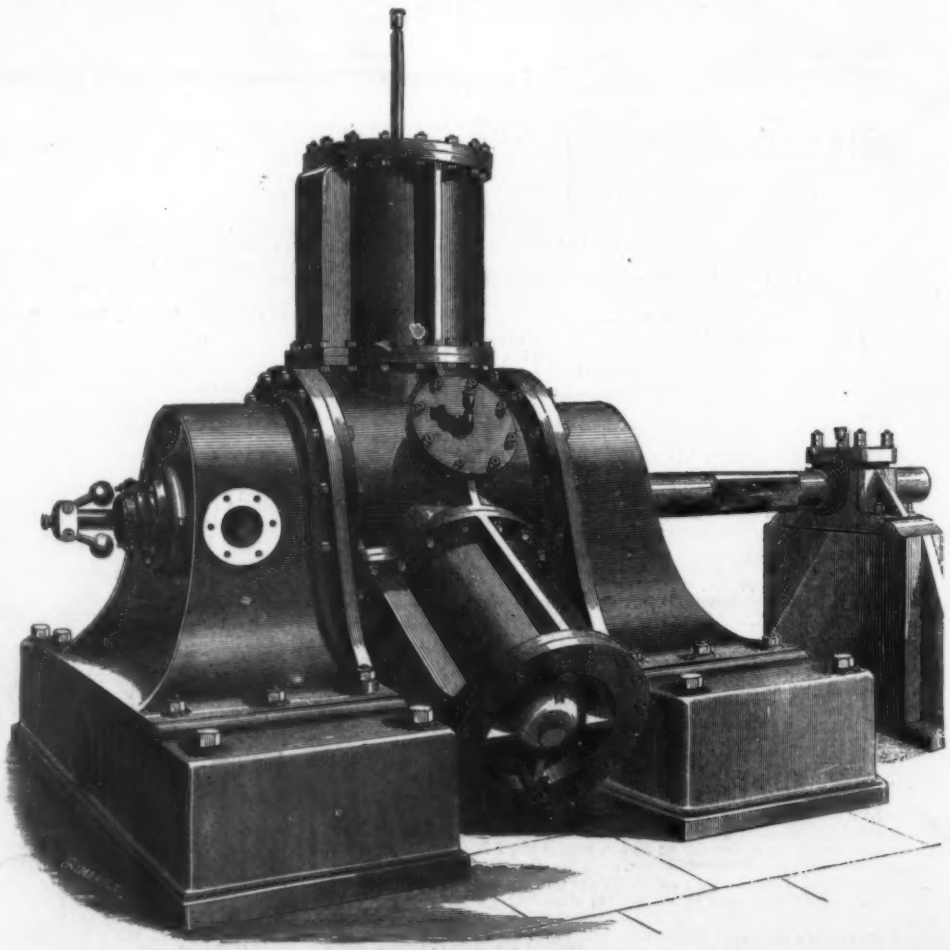
The first essential of a good joint is elasticity sufficient to accommodate the movements of the piping inevitably produced by the above-mentioned causes. India-rubber is naturally indicated, but its use hitherto has not given results commensurate with the expectations formed regarding it. M. Roche, however, has studied afresh in all its details the possibility of getting good jointing out of it, and has combined a system which lends itself, it is claimed, to the most varied circumstances in which the necessity of a good joint is felt.



ELASTIC PIPE-JOINTING.

Fig. 1 is a section of the india-rubber ring used to cover the joint; Fig. 2 shows it in position on the end of a pipe; in Fig. 3 the ring is folded back before covering the extremity of another pipe; in Figs. 4 and 5 can be seen the form taken by the ring before and after the application of the collar; Fig. 6 is an exterior view of the closed joint. An india-rubber washer is placed between the extremities of the two pipes.

There is claimed for this system of jointing the advantage that it resists considerable pressures and preserves the joints perfect while opposing their separation; it is elastic, and compensates the effects of contraction and expansion; it is easily applied, the pieces being simple in form, and piping can be put up rapidly in any position, horizontal, vertical, or inclined.



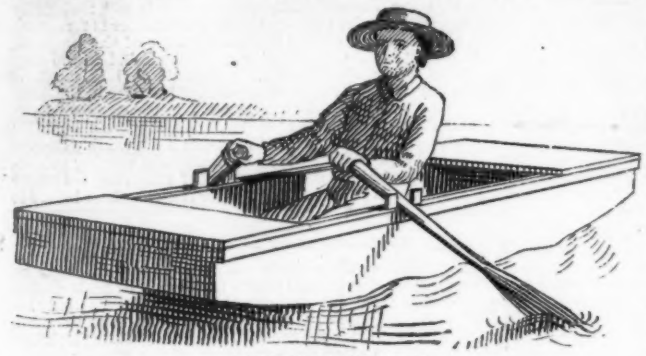
THREE-CYLINDER STEAM-ENGINE.

HOW TO BUILD CHEAP BOATS.

By PADDLEFAST.

No. 1.

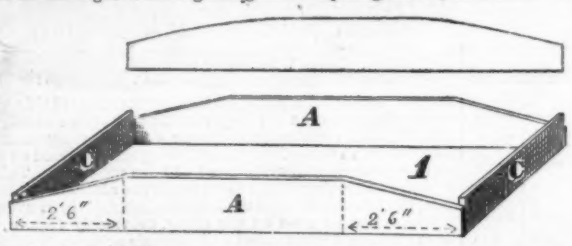
IN the following series of papers, it is designed to give plain practical directions and illustrations, of such a nature that any person, possessing only a modicum of skill, may provide himself, at the smallest cost, with a serviceable craft, according to the patterns selected.



A THREE-DOLLAR SCOW.

Perhaps the cheapest and most easily made boat is the Scow, shown above, the construction of which we will proceed to set forth.

Procure eight or nine boards of ¾ in. pine, 8 or 10 in. wide; one pine board 1 in. thick and medium width; a pound of five-penny nails, and half a pound of same sized wrought nails. Plane the boards on both sides and both edges. Select two of the clearest and best boards, 10 in. wide. Saw them 10 ft. long, making square ends of course. Then taper the ends down to 4 in. wide, making the shape shown by A A, Fig. 1. Round off the edges at the beginning of the tapering section,



giving the form of diagram above (Fig. 1). The curves should be gradual, and exactly the same on both boards. Saw out two other pieces, each 4½ in. wide, 1 in. thick, and 2 ft. 10½ in. long. These are the end pieces. Place the boards A A, Fig. 1, parallel on their straight edges, and between their ends place the end pieces C C. The ends of the side boards A A are to lap over the ends of the end pieces C C, and the upper edges of the end pieces should project a little above the level of the side boards, as Fig. 1 shows. Nail the side boards securely to the end pieces, making square corners. All the nails used throughout must be countersunk.

Nail bottom boards, 3 ft. long, crosswise upon the edges

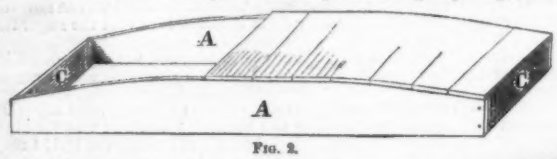
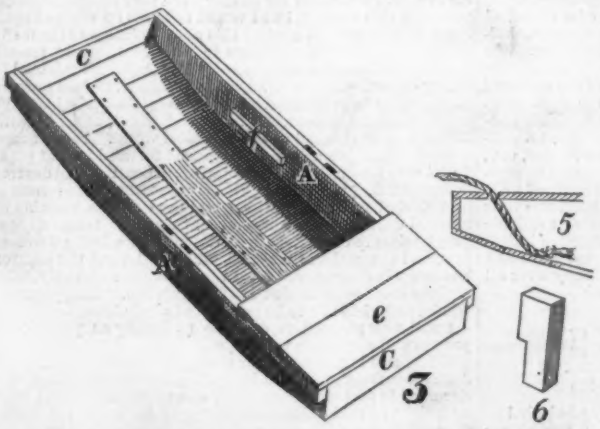


FIG. 2.

of A A, Fig. 2. The edges of the bottom boards should fit together closely; about six nails may be used in every board. After planing the edges of the end pieces C C, Fig. 2, sufficiently to make a good joint, lap the bottom boards over them.

After covering the whole bottom in this manner, cut two strips, each 10 ft. long, 1½ in. wide, and 1 in. thick. 4 ft. 5 in. from one end of each strip cut a notch on the side, ½ in. deep and 1½ in. long, and 3 in. from this notch, or 4 ft. 8 in. measuring from the same end, cut another same size. Turn the boat over, and nail these strips on the upper edges of the side boards A A, Fig. 3, on the outside of the same, with the notches inside. Use clinched wrought nails a foot apart. The mortises so formed are the rowlocks, hence those on one side must be opposite those on the other. Near the rowlocks the strips must be more securely fastened than elsewhere. The end of the scow nearer the rowlocks will hereafter be called the stern.

Place a ¾ inch board in the middle of the bottom inside



(Fig. 3); bend it down against the bottom, and nail through the bottom boards into it, where the dots in the diagram indicate, two wrought nails in each bottom board, clinched inside. This board will hereafter be known as the long bottom board.

Place two boards crosswise, 3 ft. 2 in. long, at *e*, Fig. 3, and nail them to the edges of the side boards A A. The opposite end of the boat is covered in the same manner.

Nail a cleat about a foot long on each side of the boat inside, at *f*, Fig. 3, with its aft end 5 ft. 4 in. from the stern, and its upper edge 6½ in. below the edge of the side board. These cleats should be fastened with clinched wrought nails; they are to support the seat board, which is 2 ft. 10½ in. long.

Make four oak tholepins (Fig. 6) ½ in. thick, 4 in. long, 1½ in. wide, with a shoulder projecting over about an inch. Fit them into the mortises, and thus complete the rowlocks.

Pine or cedar will do for the oars, which should be 5 ft. long, 1¼ in. diameter at handle, 2 in. diameter immediately below; blade, 18 in. long, 5 in. wide, and ¾ in. thick. Every part of the oar that will fall outside the rowlock when rowing should be as light as due regard for strength will permit.

Bore a ¾ in. hole in the bow seat, through it run the end of a small rope, and knot it inside (Fig. 5). This rope is called the "painter"; it should be about 9 ft. long.

Wedge cotton evenly into all the seams and cracks on the outside of the boat, except the end seats, leaving space above the cotton at least ¼ in. deep. Then fill the seams, and cover all the nail heads with putty.

If the builder is a good carpenter, he can fit the joints so closely that no caulking will be necessary; thick paint, daubed into the cracks as the pieces are nailed together, being sufficient. A better method than caulking for this kind of boat, even if the joints are not neat, is to lay a strip of thick flannel, ¾ in. wide, saturated with paint, between the pieces as they are put together. This strip must be placed in every seam that can be seen on the outside of the boat.

Two coats of paint will suffice. A neat and convenient color is a mixture of white lead and lampblack, forming a lead color. Use a lighter shade for the inside than for the outside.

Let the paint harden for several days; then launch the boat with appropriate ceremonies.

The seams usually leak at first, but a week's soaking closes them.

The cost of all materials for this scow ought not to exceed three dollars.

In our next article we will illustrate how to build a skiff.

DEEPENING CHANNELS TO REDUCE FLOOD-HEIGHT.

TO THE EDITOR OF THE SCIENTIFIC AMERICAN:

I have been much interested in the article written by Jas. B. Eads, published in No. 11 of the Supplement, and also your remarks thereon in the Scientific American, same date. I think, however, that there is nothing remarkable in the fact that there should be such diametrically opposite views of the subject in question between the U.S. Government Engineers and Mr. Eads; the reason to me seems plain. I think the history of the world will show that, as a *general rule*, it would take a very large pile-driver to drive a new idea into the head of a government (officially educated) engineer. Accidentally, perhaps, it happens that a person with an engineer's head obtains a position, but not usually. Appointments to government schools are not usually made with reference to qualifications of candidate, but with regard to the votes their friends can command. Is it any wonder, then, that, as a general rule, their heads are thick? They have been educated to travel in the well-worn groove of old-fogyism, and their track is so firmly spiked that it takes a heavy lever to tear it up and switch them off to another road. The principle upon which Mr. Eads has gone to work is well known to all persons who have had experience in ground sluicing in a gold placer-mine, and the only wonder is that it had not been applied long ago. If a hydraulic miner wants the water to cut away the dirt, he keeps it together. A greenhorn will let the water scatter out, and do nothing. The fact that the water of the Lower Mississippi is not charged to saturation with sediment, seems favorable to the scheme of deepening the channel. Let the channel be straightened and the water kept together, and I do not see how any one with a head that is not thicker than a board can arrive at any other conclusion than the one advocated by Mr. Eads.

I think Mr. Eads could carry his idea still farther, and facilitate the work very much by combining the hydraulic principle of placer-mining with that of ground-sluicing. The following sketch will show my idea.

A boat is to be provided with a powerful steam pump; a pipe or pipes, discharging from the pump through hydraulic nozzles into the sedimentary deposits. These when raised will be carried off by the current. The same principle could be used for clearing channels obstructed by sand-bars that would not admit of the passage of the boat, by placing the pipe ahead of the boat instead of at the stern.

I think the force of the water through the pipe would perhaps propel the boat at too rapid a speed up the stream, in which case the boat could be held back by suitable floats for the current to act on. No person who has not seen a powerful hydraulic at work on a bank of dirt can conceive the rapidity with which the dirt is cut away and moved off by the ground-sluice, or the hardness and toughness which such a stream will overcome. I have no doubt but what one engine of 100 horse-power would do as much work as 1000 engines of 100 horse-power, each applied by means of dredges. I know that in a stream of the immense size of the Mississippi, it would require quite a fleet of boats to accomplish the work rapidly, but still it would not take nearly as many as, at first thought, one would suppose, for the reason that the action of the current will cut away a large space between the separate narrow channels that would be formed by the action of the pipes. It is undoubtedly true that the action of the water if confined to one channel will ultimately deepen the river bed and reduce the flood-height of the water, but the question then arises, will not the flood-height of water raise above the banks and levees and wash them out before the river as confined has a chance to scour or ground sluice out its bottom. By the plan I propose, the channel could be deepened up to the point where another channel or pass puts out, which might then be closed with safety, and its water turned into the deepened channel, which could be still farther deepened by the additional and increased velocity caused by the increased volume of water and the action of the pipes. The same plan should be used in all places where it is practiable to make a cut-off, and by that means increase the grade of the river; the channel should first be deepened up to the foot of the cut-off. I am well aware that this scheme will be pronounced by many engineers and others as wild and impracticable; they will assume that I propose by mechanical means to move the vast and almost incomprehensible amount of earth that is necessary to be moved for hundreds of miles in order to deepen the channel appreciably. They will please bear in mind that I do not propose any thing of the kind; all that is needed is to start the bottom by means of the pipes, and let the immense force of the river do the work of cutting out and carrying off the material.

From an examination of a sketch of U. S. Coast Surveys of the delta of the Mississippi, I find that it is about 35 miles from South Pass to Fort Jackson, and only about 2 or 3 miles from Fort Jackson south to the Gulf. Would it not be feasible to turn the river into the Gulf at that point, and thus increase the grade of the river very materially? There may be a great many things to prevent the feasibility of this plan; it is only a suggestion, and may have been thoroughly examined.

Respectfully yours, G. Z. FOOTE.

HELENA, MONTANA TER., May, 1876.

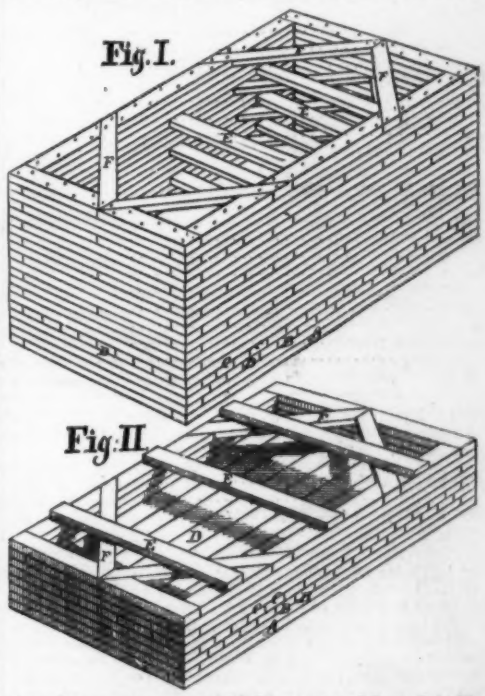
IMPROVEMENT IN BREAKWATERS.

By JOHN G. BRUGGEMAN, Cleveland, O.

CONSISTS of walls constructed of boards or planks, crosstied and braced in such a manner that it shall possess adequate strength, and be sufficiently tight to hold a sand filling, the object being to lessen the cost of construction.

Fig. 1, perspective view of the crib. Fig. 2, sectional view.

I take boards or planks of two or three inches in thickness, and eight to twelve inches in width, planed or dressed on one side, and first make a foundation-frame of two courses, A, Figs. 1 and 2, taking care in each and every course to break joints, each course of plank being spiked to the next below, using spike of sufficient length to reach through three thicknesses of planks. Upon the said frame A I next lay a floor of



plank, B, crosswise, over which I lay a second floor, C, in like manner, but breaking the joints as shown; then over this I lay a third floor, D, the planks lying lengthwise of the crib, and crosswise of the planks of the two first floors. Upon this bottom or base I lay the walls for the sides and ends of the crib, and at suitable intervals placing cross-pieces E between the side walls, and braces F F at the corners to give strength to the structure. The different layers of plank composing the walls are arranged so as to break joints, and, being firmly spiked together, form tight walls, capable of holding and retaining a filling of sand or common earth.

This makes a substantial and durable breakwater, which may be built and towed to the required position and filled with common earth, always at hand, and thus saves the expense of stone for that purpose. It also makes a good foundation upon which to build a superstructure.

OILS AND FAT DESTRUCTIVE TO IRON.

AT a meeting of the Industrial Association of Moravia, held at Brünn, M. G. Rückensteiner commented on the destructive influence of pure animal and vegetable fats upon steam engines and boilers. These bodies are decomposed by the action of high pressure steam and fatty acids (such as the margaric, stearic, oleic, &c.) are set at liberty, and attack the iron, as he has demonstrated in a series of experiments. He therefore recommends as the only means of preserving machinery the use of such mineral oils as boil at high temperatures, whereby wear and tear of machinery and the consumption of grease are reduced. Mineral oils do not contain fatty acids, are incapable of being decomposed, and do not form insoluble soaps. If they become mixed with boiler-incrustation they diminish its tendency to cling to the sides of the boiler, and thus exert in this respect also a beneficial action.

ON THE PREPARATION OF DEXTRINE-MALTOSE (MALT SUGAR) AND ITS USE IN BREWING.

By WM. GEO. VALENTINE, F.C.S.

Royal College of Chemistry, South Kensington.

[A paper read before the Chemical Section of the Society of Arts, London, March 17th, 1876, Prof. Williamson, F.R.S., in the Chair.]

(Continued from page 343.)

MALT SUBSTITUTES.

Seeing thus what beer is, and what its requirements are, we may turn to the consideration of the substances, hitherto used as substitutes for malt, in its preparation; and an examination of the character and composition of these bodies, and their behavior when submitted to the action of yeast, will show us the success that may be expected to attend their use. Malt being sweet—and it not being understood to what the sweetness was due—cane-sugar, invert-sugar, and glucose or so-called saccharines of various kinds have been proposed as substitutes.

The first substance employed as a substitute for malt to be considered is cane-sugar. The properties of this body are too well known to require to be closely examined here. However, a few words will not be out of place.

Cane-sugar occurs in well-defined crystals as sugar-candy, and in small crystals more or less impure in the different kinds of brown sugar, loaf-sugar, etc. It has a specific rotatory power of 73.8°. A solution of cane-sugar does not reduce cupric oxide. If 2.6 lbs. of this sugar are dissolved in pure water, and the solution made up to 1 barrel (36 gallons), an extract of 1 lb. brewer's gravity would be obtained; that is, 59.8 lbs. of it, dissolved in pure water and made up to 36 gallons, this solution would have a brewer's gravity of 23 lbs. This means that the 36 gals. would weigh 23 lbs. more than the same bulk of water.

If cane-sugar be submitted to the action of yeast it will be found, if sufficient yeast be added, and the temperature of the mixture be maintained at from 20° to 30° C., that the whole of it ferments in four or five days, and yields 51 to 51.5 per cent of alcohol, together with a certain proportion of succinic acid, glycerine, and other products. If an insufficient amount of yeast be added, the fermentation will not be complete. It is possible to ferment 30, 40, 50, and 60 per cent, or the whole of the cane-sugar, by varying the quantity of yeast, etc.; but if in the solution an albuminoid and the necessary inorganic constituents of the yeast-ash (phosphates, etc.) be present, the whole of the sugar slowly and gradually disappears. The residue left on fermenting a portion of the cane-sugar always tastes acid and "thin;" the acid taste is no doubt due to the succinic acid, and the thinness to the peculiar sharp bodiless taste of the sugar.

Keeping these points in view, let it be supposed that one third of the malt-extract in the pale ale mentioned above be replaced by cane-sugar; the wort before boiling would then have the following composition:

	Per 100 parts by measure.
Cane-sugar	5.57
Maltose	4.53
Dextrine	2.14
Other carbohydrates, fermentable	2.20
Ditto, non-fermentable	0.99
Albuminoids	0.98
Ash	0.11
	16.52

After boiling with the hop it would contain—

	Per 100 parts by measure.
Cane sugar	5.57
Maltose	4.53
Dextrine	2.14
Other carbohydrates, fermentable	2.53
Ditto, non-fermentable	0.66
Albuminoids	0.70
Hop extract	0.39
Ash	0.21
	16.73

The analysis is of a beer in which the same amount of hops was used as in the previous case. The numbers are before fermentation. It contains:

Cane-sugar	5.57
Maltose	4.53
Fermentable carbohydrates	2.53
	12.63 in 16.73 parts.

That is, 75 per cent of fermentable matter.

Within certain limits it is in the hands of the brewer to ferment as much or as little as he likes of this, before he puts the beer into the cask finished. But after this he has no control over the beer; he can not possibly separate every yeast-cell; hence, as long as the immediately fermentable bodies are present, the fermentation will go on, and stop only when the albuminoid and ash constituents of the beer become exhausted and even then a portion of the yeast may live and work on the product of the decomposition of another portion. Thus it is that cane-sugar can never be used as a substitute for malt in the brewing of keeping beers. Keeping, even for a short time, attenuates them so much that all body and flavor is gone. During fermentation, of course, the normal quantity of albuminoids is taken out of the solution, and if the original gravity of the beer at any stage were determined by the method of Graham, Redwood, and Hofmann, the result would be always the same as that at first determined by the brewer before fermentation. Hence the debit and credit sides of the account of the advantages to be derived by the brewer from the use of cane-sugar are, irrespective of its cost—

In its favor:

1. The reduction of the relative quantity of albuminoids in the beer.
2. Its maintaining the strength of the beer after fermentation, by yielding the same quantity of alcohol as the sugar of the malt-extract does.

Against it:

1. Its fermentability.
2. The thin taste of its solution after fermentation. The first of these has rendered it useless to the brewer of keeping-ales, without any consideration as to its cost. No matter how it be managed, it always gives a "thin, poor" beer.

The next substance to be dealt with is the so-called "invert-sugar." Of this I have before me the analysis of two samples. They appear as semi-solid, straw-colored, honey-like substances.

No. I. gave 85 per cent, and No. II. 86.88 per cent, of solid matter. Hence if they yielded as much alcohol as cane-sugar, they would be of as much use to the brewer as cane-sugar, only that 85 parts of cane-sugar would go as far as 100 parts of No. I., and 86.88 parts of cane-sugar as far as 100 parts of No. II. but 100 parts of cane-sugar yield 105.26 parts of invert-sugar.

	Percentage composition of two samples of so-called Invert-Sugar.	
	No. I.	No. II.
Cane-sugar	13	26
Invert-sugar	87	74
	100	100

Their value as substitutes for malt can be easily estimated from what has been said above upon cane-sugar, and from the fact that invert-sugar only yields 48 to 49 per cent of alcohol by fermentation.

The next set of bodies with which we have to deal are the so-called "saccharines" or "glucoses," etc., produced by the action of sulphuric acid on starch or starchy substances—rice, maize, etc. One firm advertises these substances as "saccharine" containing:

Grape-sugar	83.65 per cent.
Moisture	14.81 "
Ash and loss in analysis	1.54 "
	100.00

Another, as "patent grape-sugar," a third, as "maize saccharine;" a fourth, as "malt saccharine;" and so on.

It is only necessary to understand the action of ferments on starch, to infer pretty closely what all these bodies are; and, knowing this, we have only to look at the analyses of the wrot and hopped beer given above, to arrive at a pretty fair notion as to the value of these bodies to the brewer. They are all sent to the brewer in the form of light brown to perfectly white, not brittle, lumps or chips. They can be cut with a knife, and they break with a rough fracture.

I subjoin the analyses of five samples of saccharines, from different makers:—

Sample No. 1.—Rather brown; very hard; English manufacture.

Sample No. 2.—Pale straw-color; softish; French manufacture.

Sample No. 3.—Rather white; somewhat hard; English manufacture.

Sample No. 4.—Rather white; somewhat hard; German manufacture.

Sample No. 5.—Whiter; somewhat hard; German manufacture.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Glucose	80.0	58.85	67.44	63.42	61.46
Maltose	None	14.11	10.98	13.50	13.20
Dextrine	None	1.70	None	None	None
Neutral carbohydrates, with a little albuminoids	8.2	9.38	4.30	8.40	8.60
Ash	1.3	1.40	1.60	1.50	1.60
Water	10.5	14.56	15.70	13.18	15.20
Total	100.00	100.00	100.00	100.00	100.00
Total solid matter	89.5	85.44	84.30	86.82	84.80
Percentage of matter of use to the brewer	80.0	74.66	78.40	76.92	74.60

These analyses require little explanation, and very little comment of any kind.

The glucose is of the $C_6 H_{13} O_6$ type, and yields only 48 per cent to 49 per cent of alcohol on fermentation; that is, 105 parts of it are only of the same value to the brewer, in producing alcohol for his beer, as 100 parts of cane-sugar or maltose. From this and the low percentage of fermentable matter which these saccharines contain, it is obvious of what little value they are to the brewer, especially when it be considered that he has to pay duty on the total weight, water included.

Four out of the five contain maltose and only one contains a small percentage of dextrine.

The neutral carbohydrates are useless to the brewer for although they increase the specific gravity of the beer, they are devoid of taste and "body-giving," properties. They, under no condition, yield alcohol, and can not be converted like dextrine by the slow and gradual action of the beer into bodies capable of yielding this substance. My time will not allow me to pursue the consideration of these inert bodies.

If the analyses of these saccharines be examined and compared with that of the malt-wort given above, it will be seen that they have only one constituent in common—namely, maltose, and this exists in the saccharines in such small quantity, as to be of little consequence. It will be noticed, also, that the malt-wort contains a small proportion, 1.6 per cent, of non-fermentable carbohydrates other than dextrine, but this, like dextrine, is capable of complete conversion into fermentable sugar by the slight acid action of the beer, and infinitely more rapidly than that body. In an old beer it is almost altogether absent, whilst the "body-giving" dextrine remains almost intact. These carbohydrates of the malt-wort are the low ones of the $C_6 H_{10} O_5$ type, and not the high ones (contained in the saccharines) of the $C_6 H_{14} O_7$, etc., type.

The latter may be looked upon as the result of a chemical reaction which has gone too far—that is, the continued assimilation of water molecules has given rise to non-fermentable bodies.

A consideration of these facts, a knowledge of the action of malt-extract on starch, and the discovery that the same reaction takes place with sulphuric acid, within certain easily definable stages of the process, led us to the idea that a substance could be produced from the starch of rice, maize, etc., by the action of an acid which would have the same composition and properties as that derived from the starch of malt by the mashing process in the manufacture of beer, and thus render the cheaper grains, such as rice, etc., more available and suitable for brewing operations. This substance is dextrine maltose. A slight consideration of its composition and properties will show at once its great superiority over all other malt substitutes offered to the brewer.

It contains in 100 parts in round numbers:

Maltose	67
Dextrine	33
	100

Maltose yields the same proportional quantity of alcohol as cane-sugar does, and the alcohol it yields is, in flavor, as far superior to the raw alcohol of the glucose of the saccharines as that of fine malt whiskey is to potato spirit. In fact, the fine flavor of malt spirit is due to the fermentation of maltose, and that of the so-called potato spirit to that of glucose. This is another reason why the saccharines have not come into more general use. If we go back to the analysis of the most carefully prepared wort of pale ale, we find that it contains maltose 6.7 grams in 100 c.c.; dextrine, 3.3 grams in 100 c. c., and as these substances within certain limits are the most important to the beer, it will be easily seen that we can increase them without in any degree altering the character of the beer, either in composition, color, or in flavor, by the addition of a proportion of dextrine-maltose. It will be seen, too, that the fermentability of the beer is not materially changed. Sixty-four per cent of its solid matter is fermentable, whilst 67 per cent of the solid matter of the proposed substitute "dextrine-maltose" can yield alcohol in the first stages of the brewing process. Thus it is obvious, too, how by its use the proportions of albuminoid matter in the beer can be reduced without changing the fermentability of the liquid. There is far more yeast-forming albuminoid matter in malt-wort than is required to ferment its saccharine constituents, and an addition of dextrine-maltose in varying proportions will have the additional effect of removing a further quantity of this yeast-forming matter from the beer before it goes into the casks.

MANUFACTURE OF DEXTRINE-MALTOSE.

The process which we have adopted is a close imitation of the transformation process which the starch of malt undergoes during a properly-conducted mashing process; only instead of making use of the converting action of the soluble albuminoid bodies found in malt, we employ dilute sulphuric acid, in order to effect the conversion of the starchy matter found in rice and other grains, and we arrest its converting action as soon as the requisite proportion of dextrine and maltose which I have shown you to be present in properly mashed malt, has been reached.

The opinions held by chemists, even within more recent years, have varied considerably, regarding the actual nature and proportional quantities of the products of transformation found in malt-wort. The French chemist Musculus, who may be said to have made starch and sugar his special study, thought that the starch molecule consisted of $C_{18} H_{30} O_{15}$ and was resolved by diastase, with assimilation of water, into one molecule of glucose, and two molecules of dextrine, according to the equation

$$\underbrace{C_{18} H_{32} O_{15}}_{\text{Starch.}} + \underbrace{O H_2}_{\text{Water.}} = \underbrace{C_6 H_{12} O_6}_{\text{Glucose. (one third).}} \times \underbrace{2\, C_6 H_{10} O_5}_{\text{Dextrine. (two thirds).}}$$

Another eminent French chemist, Payen, contested this view, and held that more than 50 per cent of glucose formed, and that diastase possessed the power of converting dextrine likewise into glucose, but that the conversion ceased as soon as a certain quantity of sugar had been produced. This he thought of proving by the fact that in the alcoholic fermentation, the dextrine is acted upon by diastase, and the conversion recommences as soon as the sugar, previously formed, has been converted into alcohol and carbonic acid.

A German chemist, Schwarzer, agreed with Musculus' view of the splitting up of the starch molecule, but differed from him in supposing that dextrine is formed first, then sugar, and that the reaction ceases when definite equivalent proportions have been produced. He also held that the product obtained when the reaction takes place above 65° always contained less sugar than that produced at a lower temperature. Above 65° to 70° C. the proportion he stated to be as one mol. of glucose to three mol. of dextrine, below 60° C. as one mol. to one molecule.

I mention this briefly in order to show that the views held by the chemists of the day, up to a very recent date, regarding the breaking up of the starch molecule were any thing but orthodox or concordant. The confusion, as we can now readily see, arose evidently from the fixed idea that the sugar formed was glucose.

With the discovery of maltose, and the clear definition of its character and properties, the difficulty altogether disappeared. This body being a simple compound, reducing only two thirds as much cupric oxide as glucose, and being totally fermentable, led to the idea that dextrine was fermentable and soluble in alcohol, because the portion of it, if I may use such an expression, which did not reduce cupric oxide was looked upon as dextrine, whereas in reality it was part and parcel of the new sugar maltose. This is not an isolated case. Lactose, a well-defined body, reduces only as much cupric oxide as $\frac{4}{10}$ of glucose. The other $\frac{6}{10}$ might just as well be called a dextrine as the one third was which corresponds to the non-reducing power of maltose.

This conception of a dextrine, soluble in alcohol, or Gamma dextrine, is but of recent growth. It did not matter that such a dextrine had never been isolated, nor that it ran counter to all the knowledge we possess of the chemical and physical properties of dextrine, such as insolubility in alcohol, total absence of copper oxide reducing power, colloid nature when dialyzed, etc. Nor need I have troubled you with this phase of chemical opinion if an attempt had not come to my knowledge, to jeopardize, as I venture to think, a well-earned discovery by manufacturing the all but identical article, which we have called, in accordance with its well-established chemical constitution and properties, dextrine-maltose, calling it, however, by the unmeaning name "dextrum." I must crave your indulgence for having even for a moment detained you with this subject, but I would not pass on without entering a decided protest against this new evolution of the theory on the fermentation products in malt-wort. That maltose is not a mixture of a mythical dextrine, soluble in alcohol (or of any other known or unknown properties), and of ordinary glucose, has been conclusively shown by O'Sullivan in a paper recently read before the Chemical Society, and submitted through that channel to the chemical world. From among several conclusive arguments brought forward in that paper, I will only quote that when a mixture of dextrine and dextrose is fermented, the dextrose alone undergoes transformation into alcohol and carbonic acid, and the dextrine remains untouched during 10 or 12 days even. Again, in a carefully-prepared mixture of maltose and dextrose, the latter ferments first, and the maltose remains untouched until the dextrose has entirely disappeared from the solution, and, lastly, when maltose itself was submitted to fermentation, it disappears as a whole, and yields 51 to 52 per cent of alcohol.

I will now proceed to describe as briefly as possible the process and apparatus we employ.

When rice is employed for the purpose of manufacturing dextrine-maltose, it should be husked and finely ground. The rice-meal is first steeped in from one to one-and-a-half times its weight of cold acidulated water, or in water not higher than 40° C., and thoroughly agitated by mechanical means. It is then gradually introduced into acidulated boiling water, in the proportion of 100 parts by weight of rice to 250 by weight of the latter, care being taken not to allow the temperature

to fall much below 90° C. The amount of acid—by preference sulphuric acid—may vary. We employ from one and a half to 2 or 3 parts per cent. A dilute acid is preferable, for although the converting action is not quite so rapid, it proceeds much more regularly.

The vessel in which the rice-meal is converted consists of an ordinary mash-tun, lined with sheet-lead and provided with steam-coils and a stirrer.

As soon as the rice has become thoroughly diffused throughout the boiling water, a rapid conversion is observed. The liquid boils up briskly, and the steam has to be checked for a while to prevent its boiling over. This action is evidently owing to a chemical change. The rice-paste becomes rapidly thinner, when kept at a boiling temperature for about an hour or an hour and a quarter. It is best and most expeditiously tested by neutralizing a sample with baryta-water or chalk, filtering and examining the clear solution by means of the polariscope.

The conversion may be considered complete when the rotatory power is + 171° or thereabout, indicating two parts of maltose (rotatory power + 150°) and one part of dextrine (rotatory power + 213°); that is,

$$\frac{2 \times 150° + 213°}{3} = 171°$$

By always infusing the same quantities of rice-meal and keeping up the same temperature, it is possible after a few experiments, to dispense with the polariscopic determination altogether, and to obtain a liquor containing the proportionate quantities of dextrine and maltose, as they are found in malt-wort. The acid liquor is then carefully neutralized with good chalk to the extent of about 90 per cent, finishing off with milk of lime. This operation can be carried out with the greatest delicacy. It is preferred to leave the liquor, however, rather a trifle acid than alkaline. The strength of the liquor, after filtering off the grains and the gypsum through Taylor's filtering-bags, usually amounts to 1115 to 1125, or 30 to 32.5 per cent of solid matter—that is, about double the strength or original gravity of malt-wort required for brewing strong ales. It is of a light amber color and filters very readily. It is next evaporated either in an open pan, or with greater advantage in a vacuum-pan, to a concentration of about 1200, or about 52 per cent of solid matter. A little more gypsum and a little flocculent albuminoid matter are at this stage best separated by filtration, and the concentrated liquor, finished off in a properly constructed vacuum-pan, or in an open steam-jacketed pan, provided with an agitator, till it acquires a stiff viscidity. It is then run off hot into forms and cast into cakes of convenient weight which on cooling set hard, and are ready to be sent to the brewery. Seventy-eight to eighty per cent of the starch in rice, in fact every particle, can be converted into dextrine-maltose.

The cost of manufacture, as you will perceive from the description, is not more than 25*s.* to 30*s.* per ton.

It is obvious, however, that there would be a considerable advantage arising to the brewer, if, by an alteration of the present excise laws, a concentrated solution of dextrine-maltose could be employed. As the law stands at present, I am informed no saccharine matter—in fact, no fermentable substance of any kind—is allowed to enter a brewery in a liquid condition. This law presses all the more harshly upon dextrine-maltose, as this particular saccharine material could be readily obtained in the form of a concentrated liquid containing as much as from 75 to 90 per cent of solid dextrine-maltose, in which form it could be kept as easily as any solid sugar.

I have no doubt there will be a time coming when these laws will be altered, and when the brewer will manufacture his dextrine-maltose as easily as he now infuses his malt, and will run it into the coppers, together with the proper proportion of malt-wort.

I need not trouble you at this late hour with any comparative statements as to the cost of production. Knowing as you all do the cost price of rice, maize, etc., and being now familiar with the mode of manufacture, you will be able to make out your own estimate. Considering, however, that we can offer to the brewer a malt substitute containing 93 per cent of solid available matter, the saving upon excise duty must constitute an additional recommendation. I have therefore no hesitation in saying that our dextrine-maltose (for the manufacture of which I have made arrangements with Mr. John Schwartz, sugar refiner, Pelham street, Mile-end, New Town) will be found to be the cheapest and most suitable malt substitute ever brought under the notice of brewers.

The objections sometimes raised by brewers to the use of saccharine substitutes for even a partial replacement of malt in brewing can not be urged against the perfectly natural and legitimate substitute which we have called dextrine-maltose. It must be held to be quite a legitimate object for investigation, based upon correct scientific principles, and guided by experience, to solve the question what materials are capable of at least partially replacing malt in brewing, so long as the character and composition of the beer does not suffer thereby. In how far we have succeeded in doing this I may leave you to judge.

In conclusion I will now only call your attention to the results of the brewing experiment which Mr. O'Sullivan made, and of which I have bottled specimens on the table for your inspection.

(To be continued.)

RAILWAYS IN BRAZIL.

THE *London Investor's Guardian* says that the Emperor of Brazil has reasons of importance for his approaching visit to England—namely:

"About two years since his Majesty consulted Sir John Hawkshaw as to the practicability and possible advantages of a line of railway through Brazil, towards Uruguay and the Riverine of Paraguay, which would largely extend the internal trade and develop the land resources of Brazil. Our great engineer went over to Brazil and made a personal inspection of the country. He finally came to the conclusion that his Majesty would be justified in pledging the revenue of Brazil to the extent of a guarantee of 7 per cent. interest on the intended system. The operation will be a large one, and it is for the purpose of consulting and arranging with the leading capitalists of Europe, and especially of England, that the present journey of the Emperor has been undertaken."

MESSRS. PORTER, BELL & CO., of Pittsburg, recently shipped light locomotives to New-Orleans to replace mules in hauling horse-cars. These engines are covered in to resemble street-cars, and are perfectly successful. Being noiseless they do not frighten horses, and they haul a long train of crowded cars with ease. On one day 5200 passengers were carried by two locomotives.

A NEW STEAM DUMMY.

A TRIAL test was recently had on the Haddington Branch of the West Philadelphia Passenger Railway of a steam dummy made by the Atlantic Works of Boston, and the invention of James P. Woodbury. The peculiarity of this dummy consists in the comparative isolation of the engine from the body of the car. The car-body rests upon two trucks of four wheels each, which are swivelled so that a sharp curve can be turned as readily as by a small car. The engine and boiler rest upon the forward trucks and not upon the car-body, and turn with the truck; the bearings of the driving-crank are not the same as those of the wheels, but the crank shaft is entirely independent of them. The two cylinders are 7 inches in diameter and 12 inches stroke. The car, which was constructed for use on a steam road, and which would probably be modified for use upon the streets, is 30 feet long and 8 feet wide, and seats 35 passengers.

The route selected had several very heavy grades, one on Sixty-fifth street, between Vine and Haverford road, being over 300 feet to the mile. The engine backed its load up this hill at a speed of ten miles an hour, and afterwards made frequent stoppages in ascending the same grade. On other portions of the route a rate of speed equal to twenty miles an hour was easily attained. Consuming anthracite coal, there was no smoke, and the noise of escaping steam is obviated by passing the exhaust steam through a receiving tank, which muffles its sound. The dummy can be stopped within its length, when going at a speed much greater than would be necessary. The cost of running it would be much less than doing the same work by horses.

STEEL RAILS.

IN the last annual report of the Lehigh Valley Railroad Company reference is made to the steel rails used on its track as follows:

"Our steel rails are wearing well generally, although a number have broken. We have in use on main line between Wilkes-Barre and Easton, and in Beaver Meadow and Hazleton branches, 128.21 miles of track laid with steel. During the past year we have had 171 rails broken in track from various causes. The breakage of different makers varies widely, the highest being 33 rails in 5.16 miles of track; the lowest, one rail in 23.05 miles of track. I think 58 lbs. per yard rather light for our heavy track, and would recommend the substitution of 66-lb. rail, similar in section to that laid on the Easton and Amboy Railroad. The rails now in use could be used in the light car track, which is now laid with iron. We would get a very much better track, and, in my opinion, save the interest on additional cost of rails by lessening the expense of keeping up the track.

"None of the steel rails in use have absolutely worn out, but those laid at Weatherly in 1864, and in curve at Mauch Chunk depot in the year following, have become so worn as to be unsafe in main track, and will be replaced."

Some idea of the relative service of iron and steel rails may be gleaned from the following statement: "In September, 1867, new iron rails were laid on Parkerton scales. They had to be renewed in a little over a year, after having passed a tonnage of 2,263,675 tons; the second set of iron were renewed after a passage of 1,524,870 tons. Steel rails were then laid about the first of June, 1869, and remained until new scale was put in in June, 1872, when the same rails were laid in the track just above the scale, but where all coal going on the scale would pass over them. Our agent reports a tonnage of 24,298,568 tons over them, and that the rails are perfectly good at this time."

STEEL-HEADED RAILS.

IRON manufacturers will be interested in the results of some experiments recently made at the Wyandotte Rolling Mills, near Detroit. Railroad rails were made of iron base and Bessemer steel-head, so successfully welded that the most trying tests failed to show even the points of the juncture of the two metals. The same experiments showed the welded rail to be even better than the solid steel. Each was submitted to sixty blows by a twenty-ton hammer. The Bessemer rail was completely shattered, cracked through and through in every direction; the welded rail, though mashed down and twisted in the neck, showed no sign of a fracture in any part. The *Detroit Post*, from which the above is copied, says this hitherto difficult if not impracticable feat was accomplished by a peculiar metalloid sponge or flux in the following manner:

The pile is made up as for the ordinary iron rail—for the head scraps of steel, hitherto not utilized at all, are spread of the desired thickness, and upon this is laid a plate of steel. The flux, in the shape of a hard substance about the size of a kernel of corn, is scattered through and over the pile, which is then placed in the oven; when properly heated, it is drawn and rolled in the ordinary manner. It is found to be a perfectly homogeneous mass; the fibrous iron and the crystalline steel have their particles so interwoven, that it is a physical impossibility to separate one from the other. Breaking or twisting does not produce a separation at the point of the juncture. The wonderful work of uniting iron and steel, so mechanically different, in one homogeneous mass is accomplished by the peculiar flux, composed of 55 parts iron, 20 parts silicon, and 25 parts aluminum. The chemical action of these substances is explained to be as follows: The silicon takes up the alkaline matter, while the aluminum eliminates the free oxygen, phosphorus and sulphur, thus making a uniform, consistent, close-grained metal.

THE AMMONIA PROCESS OF TREATING ORES.

THIS is an improved process of treating ores and minerals for obtaining gold, silver, and other products therefrom, suggested by Dr. Thomas Clarke, of Wilmslow, and Mr. E. Smith, of Torquay. Briefly, the process consists in the solution of the copper and silver salts, after calcination of the ore, by means of ammonia and ammoniacal salts, then passing this solution through a galvanic tank, formed by a suitable and economical arrangement of sheets of platinum and copper, by which means the whole of the silver is deposited in practically a pure state, whilst the copper passes on—still in ammoniacal solution—and is precipitated as oxide, by passing steam into the solution, with the simultaneous addition of a very small amount of caustic alkali. This not only precipitates the copper as oxide, but drives off the ammonia, which may be collected for re-use. The special advantages claimed for the ammonia process are chiefly its economy and simplicity, and the purity of the products obtained.

[San Francisco Chronicle.]

THE WONDERFUL SALT MINES OF VIRGIN RIVER, NEVADA.

FROM Mineral Park to Quail Springs Ranch, the last settlement between Mineral Park and the Colorado, is eighteen miles. The next and only water for fifty-two miles is at Mountain Springs, ten miles from Nobmann's, and thence for forty-two miles the road is down the great Sacramento Valley to the north, a valley entirely destitute of water for over one hundred and fifty miles, north and south, but in many places covered with a luxuriant growth of native grasses. The northern part of this valley is called the desert, and during the hot, dry months of summer is dangerous to cross unless a good supply of water is taken for man and beast. I saw the graves of several who within four years have perished from heat and thirst while crossing, including both men and women. The altitude at this point is but 1250 feet, while at Mineral Park it is 4400. The altitude of the Sacramento Valley is greatest at or near its centre, or near Mineral Park, from which it falls each way north and south, north to Stone's Ferry, over seventy miles, and south to the "Needles," about the same distance. One mile above the ferry the Virgin River comes in from the north, and on and near it is, perhaps, the most wonderful and extensive salt formation on the continent. The formation is in fact one of mountains of salt—hard rock salt, which is blasted and quarried out like quarries of granite and marble. Commencing six miles up the Virgin River, these mountains of salt extend for thirty or more miles up the Virgin and Muddy rivers. There are openings now made from six to twenty miles up the Virgin River at different places. From six to twelve miles up these openings uncover a species of dark-gray salt, 93 per cent. pure, presenting to the casual observer the appearance of common coarse gray granite. These openings are all on the east side of the Virgin River, from one fourth to one half a mile from its banks. At a point twenty miles up the river, and on its western side, is a mountain of pure, white, crystallized salt, white as the driven snow, and transparent almost as glass. It is at once a pleasing and interesting spectacle to see the great masses of crystal-like salt as thrown out by a three or four foot blast. These pure and beautiful blocks resemble somewhat blocks of the purest ice when prepared for the ice-house. On placing a mass six inches thick over a column of the *Chronicle* the fine print could be read easily. The formation of the salt deposit is no doubt very ancient, dating back in years beyond computation. Long since the deposit was made the great upheavals and earthquake era have occurred, which have changed the whole appearance of the country for great distances around. These salt bluffs or mountains can be identified for a long distance by the peculiar color of the surface, which is of reddish or orange color. Underneath this formation, as well as in it, is a peculiar kind of micaceous sedimentary granite. I found sufficient evidence to warrant the assumption that veins of valuable mica will yet be discovered in or near the salt formation. The whole country is deserving of thorough investigation by the miner, the prospector, and the student. Another very interesting natural curiosity visited and examined here is a natural salt well a mile northwest of the ferry. It is on a mesa, which extends up and down the river on its northern bank. This mesa is a drift formation formed of small pebbles and bowlders mixed with earthy matter. The well is a large circular opening in the mesa, some 300 feet in circumference, with abrupt descent to the surface of the well, which is fifty feet below the surface. The water is exceedingly salty, far more so than any salt spring, and has been sounded to a depth of 130 feet. It is a splendid natural salt bath, on which the bather floats almost as buoyantly as a cork upon a pool of water. From a careful examination of all the surroundings, I feel confident that this interesting salt well is all that is left of a once great salt lake, which, in the lapse of time, has been filled in by the drift formation, only leaving the present opening as an evidence of its former existence. The Virgin River, near which the great salt mountains are, is a muddy, turbulent stream of 100 feet in width, and having an average depth, at low water, of about one foot. It rises some 150 miles in the mountains east of north from the ferry of the Colorado. The Colorado River is here 750 feet wide, with a depth at low water of from ten to fifty feet, and a current of three to four miles per hour. The Stone's ferry is twenty-five miles above Callville, to which point small steamers have run on several occasions. Small barges, carrying a few tons, are now towed up to the ferry from below, and salt taken down to supply the mines at El Dorado Canyon and elsewhere. The distance to Hardyville is nearly or quite 200 miles, and to the mouth of the river over 600 miles. The distance up the river to the foot of the grand canyon is some fifty miles. The whole aspect of the country as far as the eye can reach is bleak, barren, and desolate in the extreme; hardly a bush, shrub, or blade of grass is to be seen.

LABOR IN MASSACHUSETTS.

IN the seventh annual report of the Bureau of Labor Statistics, just published, returns are given from 80,893 persons, 63,263 of whom are males, and 17,630 females; 71,339 are of the "wage" class, and 9,554 of the salary class; 47,864 of the total number return 142,386 persons dependent upon them for support. From returns by employers for 254,993 employés, it is found that the average yearly wages amount to $413.37; and from returns made by 71,339 persons employed, it is found that they amount to $418.39. On the other hand, 90 per cent. of males, and 93 per cent. of females gave the average yearly earnings of the former as $482.72, and of the latter, $198.76. The highest average of yearly earnings, for males, is found to be in Suffolk County, $576.19.

From answers made by 48,747 males, it appears that the average daily wage is $2.01. The average wages of females is seen to be 82 cents, but many of them are domestics and receive their board in addition. Twenty-three per cent. of the male wage receivers are found to own the houses in which they live; 44½ per cent. of those who own houses have them encumbered with mortgages. The average amount paid for rent for males throughout the State is $109 07, and for females $93.62, which for males is 22½ per cent. of wages.

The average number of hours employed for males is shown to be 10.21, and for females 10.49, while the average for salaried persons is 10.41 for males, and 6.34 for females. The average number of days worked by males throughout the State is shown to be 241.65; by females, 258.96; and the average among salaried persons, for males, 290.29; for females, 192.37. As there are 308 legal working days in the year, it will be seen that the time lost by each male workman is a fraction more than 66 days.

A NEW cheap coating for wood which is very adherent even when exposed to the weather, consists in simply brushing the surface with a solution of persulphate of iron of 2 deg. to 2½ deg. Beaumé. The blue-gray tint which this acquires on drying changes to a brown when linseed oil varnish is applied.

FREE SILICA TAKEN UP BY PLANTS.

Prof. P. B. WILSON.

My attention was called some time since, in the examination of the ash of plants obtained by slow incineration in a platinum crucible, to the fact that when the ash is treated with dilute acid, and evaporated to dryness on the water bath, it does not pass into the gelatinous condition prior to complete decomposition of the *hydrated* mass, as is the case with the silicates soluble in acid, or those decomposed with sodium and potassium carbonates. If, however, the ash, prior to the treatment with acid, is subjected to a high temperature, a combination of silicic acid with the alkalies, the alkaline earths, and the earths takes place, if all are present; then the silica separates in the gelatinous form and presents all of the chemical reactions of silicic acid obtained from the natural silicates. The silica obtained from ash by either of the processes indicated, on close examination, was observed to be entirely free from any combination, showing that it had been assimilated in the free state.

To demonstrate this theory, my friend G. I. Popplein, Esq., of this city, suggested the application of infusorial earth of the Richmond formation—found in large quantities on the western shore of the Chesapeake Bay—to land sown in wheat. I have obtained straw from wheat so grown, and have found, after it has been treated with nitric acid, and the siliceous remains placed on the field of the microscope, that it consisted wholly of the siliceous shields of Diatomaceæ, the same as found in the infusorial earth, excepting that the larger discs in their perfect form were absent (*Actinocyclus Ehrenbergii* and *Actinoptychus undulatus*). My conclusions are that they, and there probably may be other forms, are too large to enter the root capillaries. During the coming summer I will attempt if possible to make micrometer measurements of both.

The discovery of Diatomaceæ in their original form in this wheat straw precludes the possibility of the infusorial earth having undergone any chemical change in the soil, either by forming chemical combination with the alkalies, or the earths, or by suffering physical disintegration from any catalytic action of any salts present in the soil.

In the particles of silica placed upon the glass slide, when they were completely separated from each other, the outlines of the individual diatoms were sharply and distinctly defined. On the other hand, when the physical action of ebullition with nitric acid was not sufficient for the complete separation of the particles of the epidermal shield, there was observed a marvellous interlacing of the various forms, showing that they were conveyed by the sap cells directly to the section of the plant where they were destined to complete its structure. I have examined several specimens of straw, taken at random in the market; the silica in each specimen consisted of plates, very thin, and truncated at the corners.

The result of these investigations shows the necessity of finely divided silica in the soil, so minute as to be capable of passing with facility through the sap cells; secondly, that simple or compound silicates are useless as fertilizing agents, either natural, or artificially prepared. We have no valid reason for forming any theory that vegetation can, through any known chemical law, separate the elements or their compounds from combinations so positive in their character.

In this case we have a practical result, capable of being verified at any stage of growth of a plant, produced by the application of silica to the soil in the form of certain well defined microscopic organisms; for finding these in the ash to the exclusion of other particles of silica, they seem to be more acceptable for the plant structure. Free silica is hence the only condition in which it can enter the plant.

I look upon this discovery as leading agricultural investigations in a new direction, and it must eventually change many of the views expressed and accepted by scientists.

Every precaution was used in having all the material thoroughly cleansed, with a view both for accuracy and for removing suspicions that these microscopic forms were the result of dust showers. [American Journal Science and Art.]

WASHINGTON UNIVERSITY, BALTIMORE, MD., Feb., 1876.

RESOURCES OF AFRICA.

THE Turners' Company, London, lately presented their freedom and livery to Lieutenant Cameron, R.N., for his recent exploration of the African continent. The master then clothed him in the furred robe, and, invested him with the company's badge, and then, presenting him with the certificate of honorary freedom, offered him the congratulations of the company. In returning thanks, Lieutenant Cameron said:—"The country of Africa which I have traversed, and especially to the west of Lake Tanganyika, is one of the richest countries in the world, and if one was only in a position to give the climate a fair chance it would be found to be far more healthy than that noble dependency of the British Empire, India. Ivory, which has been mentioned as one of the materials of the turner's art and mystery, is there found in greater abundance than anywhere else. At Nyangwe the Arabs trading amongst themselves give 35 lbs. of ivory for 7½ lbs. of beads or 5½ lbs. of cowries, and very often they are able to buy a tusk irrespective of size, which may weigh from 100 to 150 lbs., by the present of an old copper bracelet or any worn-out useless thing which may take the fancy of the natives. This country of Nyange I firmly believe, in fact I am sure, may be reached by the Congo; and hereafter I hope that where my steps have been we shall see a system of English trading-stations for the purchase not only of ivory, for the richness of the vegetable products of the country is something beyond description. The people in many of the countries I have passed through are very clever smiths. They have not yet advanced to the art and mystery of turning, but some of their work turned out simply with a rough hammer without a handle, and with no file to finish off with, might favorably compare with a good deal which is shown in this advanced country of England, where we have all the appliances of modern machinery and workmanship to help us. Gold is found at Nyangwe, and I there saw an Arab who showed me a calabash full of small nuggets, or pieces of quartz filled with gold. What he showed me, he said, was found in one evening by his slave in clearing out an old watercourse to get water for his camp. He said, 'What is the good of such little pieces?' and if I had not been honest enough to tell him of their value I might have had the whole of them. But there is yet another thing which concerns Englishmen, seeing that our mastery of the position as one of the leading nations of the world depends in a great degree on our supplies of iron and coal lasting. Now in Africa, long after our last ounce is exhausted, we can find enough of both to supply the world for untold centuries. There are several different descriptions of iron ore, some very like the ore which they bring from Norway and Sweden—black speculum ore, which I believe furnishes the best iron and steel of commerce. Besides these, I also found large masses of copper. Some of this copper is occasionally brought down to Benguela by the Portuguese traders, and I was told there that a company in Lisbon, conducted by Englishmen, had been formed to take the whole of this product, as in the copper they found a certain portion of gold, and they found that extracting this gold paid them remarkably well. Silver is also amongst the products of the country, and I have every reason to believe that I have seen what will prove a valuable deposit of tin. Now the country which thus furnishes all that is necessary for commerce, and can also supply the world with the articles I have mentioned, is also opened up by two of the most magnificent systems of water communication in the world."

AFRICA.

DR. GERHARD ROHLFS, the African explorer, recently delivered a lecture before the German Fortbildungs Verein, of this city, on the commerce and industry of North and Central Africa.

In ancient times, he said, commerce on the northern coast of Africa flourished, and several of the countries enjoyed a high degree of civilization. One great hindrance to the development of the continent was the Moslem religion, whose false doctrines impeded progress, by making its followers fanatic and indolent. Almost the only article manufactured in Morocco, which is exported, is morocco leather. The art of tanning this leather the Moors brought over with them when they were driven from Spain. The other articles of export are wool and fowls. In Algiers, in spite of forty years of French rule, very little progress has been made. Frenchmen, though they are excellent cultivators of the soil, possess very small administrative powers, especially in their colonies. Ever since their conquest of the country they have shown too much leniency to the natives. Colonists of Teutonic origin have always driven before them savage and other inferior races, and have thus obtained complete mastery of their new homes. The French, however, allow nomadic tribes to encamp close to their settlements, and so long as they pursue this policy they will never be safe from revolts. The Bedouins and Berbers will not be civilized, and look upon their conquerors with jealousy and hatred. The lecturer believed that the French Government should drive these barbarians into the desert as the only way of developing the country.

Tunis, Dr. Rohlfs said, was a small but very fertile country. The production of oil was so great that one year the people did not have vessels enough to store it in. And yet hardly any of this oil finds its way to Europe, because the natives are too fanatical to sell it to Christians. Tripoli labors under an additional disadvantage, that of Turkish rule. The Pashas seek only to enrich themselves during their short terms of office, and the natives are outraged. The principal product of the Sahara oases is dates. The houses of the natives are built of the palm tree, and the leaves of the tree are made into baskets and mats. Central Africa, though isolated from the rest of the world, still carries on a greater commerce with foreign countries than many people suppose. Ostrich feathers, which are found in all European and American markets, form a prominent article of export. The negroes can not form an idea of the uses to which these feathers are applied. Some say they are woven into broadcloth. Another important article of trade is ivory, and the tusks of African elephants are of much larger size and finer quality than those of India. Arachis, the oil of a nut, is largely exported to France, where it is refined into salad-oil. Palm-oil forms another article of commerce, and in Germany is used for lubricating railroad machinery. Gold-dust also is taken to the Western coast and thence shipped to England.

M. BERT'S NEW RESEARCHES ON CHAMELEONS.

M. PAUL BERT has recently conducted a series of investigations which throw new light on the complex question of the causes of the changes of color of the chameleon. M. Bert distinguishes in these reptiles contractile corpuscles, which sometimes are concealed deep in the skin, and sometimes are scattered on the surface in innumerable ramifications. He has also recognized the existence of a yellow superficial pigment, and also of the so-called cœrulescent layer discovered by M. Ponchet. He has also verified, by applying electricity to a divided nerve, the experiments made some twenty-five years ago by Brücke, showing that the nervous system exercises a direct influence on the coloration of the tissues. Proceeding still further, M. Bert has reached a number of very striking experimental results.

By cutting the spinal marrow at about the middle of its length, *a*, Fig. 1, he is able to change the color of the reptile

FIG. 1.

to green on one part of the body and black on the remainder. All the posterior portion acquires a sombre hue, while the anterior part keeps its light color. Then, by making a section on the cervical region, M. Bert determines the almost immediate darkening of the head and of the anterior portion of the body, the nerves of which belonging to the colored corpuscles arise between the third and sixth dorsal vertebræ, and follow the course of the great sympathetic of the neck. After the section of the marrow the energetic excitation of a mixed nerve leads by reflex action to a lightening of the skin, especially on the corresponding side. By making two or three sections of the spinal marrow—for example, at *a b c* (Fig. 2)—and by producing at *b* and at *c* excitations in an opposite direction, M. Bert observes that the whole of the body takes a light green color, with the exception, however, of the enervated region between *b* and *c*, which remains blackish. By making a hemi-section of the spinal nervous axis he removes the blackening of the corresponding half of the body. When the two cerebral hemispheres, the optic tubercles, the cerebellum, and the isthmus of the encephalon are abstracted, the change of color is not produced spontaneously, but happens when the animal is excited. The destruction of a single cerebral hemisphere, which is followed by the destruction of the opposite eye, produces on the corresponding side a variation of color, much more rapid and more durable than on the opposite side; the removal of the remaining eye simply restores equilibrium. By merely taking out an eye and not a brain hemisphere, M. Bert finds that the corresponding side remains much lighter than that in which the other eye exists; but, as before, the removal of both eyes results in an equilibrium of color.

FIG. 2.

M. Bert finds that when the reptiles are asleep, light modifies their yellow color to a darker tint. It changes also their color very curiously, however, when they are awake. An odd fact is here to be noticed—that while light transmitted through dark-blue glass is active, when sent through red or yellow glass it is completely inoperative. By means of a strong lamp M. Bert threw a bright light on a sleeping chameleon, and protected by means of a scalloped screen a part of the dorsal region. He thus obtained the singular appearance shown in Fig. 3. The head, neck, claws, abdomen, and tail became of a very dark blackish-green, while the back exhibited a sort of brownish-saddle, ir-

FIG. 3.

regularly shaped, with two dark-brown spots corresponding to orifices in the protecting screen. He then placed an awakened chameleon in full sunlight, previously, however, shading its rear portion with blue glass while the light fell on the rest of the body through a red glass. As seen in Fig. 4, the result was that the body was distinctly divided into a light-green region in the front part, and colored to green-black in the rear portion.

From these facts M. Bert concludes that: 1. The different colors and hues of the chameleon are due to changes of position of the colored corpuscles, which sometimes are buried under the skin, forming an opaque basis under a cœrulescent layer, and sometimes scattered through the superficial ramifications. In the first case they allow the skin to assume its yellow color; in the second, to change its hue to green or black. 2. The movements of these chromo-blasts are governed by two orders of nerves, of which some cause them to rise from the depths to the surface, while others cause them to return to the interior of the tissues. During a state of complete repose these corpuscles are concealed under the epidermis, and this occurs during sleep and after death. M. Bert also finds that the nerves of the second class above mentioned may be compared with the vaso-dilatators, while those of the first class may similarly be likened to vaso-constrictors. Each hemisphere of the brain commands by the intermediation of reflex centres the color nerves of the two

FIG. 4.

sides of the body, but acts principally on the analogous nerves to the vaso-constrictors on its own side, and to the vaso-dilatators on the opposite side. It is thus easy to explain the singular aspect already noted of the animal when one eye is removed and the other exposed to sunlight. Since each hemisphere, through the intersection of the optic nerves, is called into play under the influence of excitations transmitted by the eye on the opposite side, it is evident that the loss of the right eye, for example, is followed by the inertia of the left hemisphere. The right hemisphere receiving the influence of the luminous rays through the left eye acts on the coloring nerves on its side analogous to the vaso-constrictors, and on those on the other side analogous to the vaso-dilatators. Hence, on the right side the corpuscles retreat and the skin becomes light, while on the left they come to the surface and the skin darkens. The removal of the left eye, if then practised, obviously paralyzes the single active hemisphere, and equilibrium follows.

It would appear from the colored glass experiment that the chromo-blasts are only influenced by the blue violet rays of the spectrum. This exciting action of light on a contractile substance—an action hitherto only recognized as belonging to heat and electricity—is one of the most remarkable and unexpected facts added to our knowledge of general physiology, and M. Bert proposes soon to continue the investigations still further in the same direction. He hopes to discover the reason of the favorable sanitary influence which direct action of light exercises upon the skin of children and lymphatic persons.